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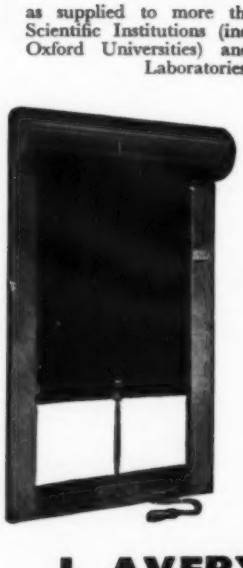

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Science in Secondary Schools

SOCIAL organization is passing through a dynamic era. To-day the rate of change is higher, and, what is more important, we are more aware of it. For this reason the Spens report* is to be welcomed as a compendium of suggestions for meeting these changes, and above all as a clear statement that the duty of citizenship in a democracy renders it essential that all should be taught to understand and to think to the best of their ability. The report, the general trends of which were outlined in NATURE of January 21, p. 103, though of far-reaching importance, is perhaps not so revolutionary as was expected, which is all to the good; for revolutionary changes, especially in such a highly organized system as that of education, would only result in confusion and counter-revolution. There is, after all, only a difference of degree between the pronouncements of Arnold and Sanderson, and those of such present-day educationists as Sir Richard Gregory, who once defined education as "the deliberate adjustment of a growing human organism to its environment". Furthermore, several of even the more important suggestions set forth in the Spens report are not new, but have already been made by other authoritative bodies. This illustrates the broad outlook and the democratic spirit adopted by the Spens Committee and the large body of witnesses which helped it in its deliberations.

Though the curriculum, it is considered, should have more regard to the vocational future of pupils rather than give so much time to training potential university students, a good general education is recommended. Thus does the report re-emphasize the recommendations made earlier by the Hadow, Malcolm and Goodenough Committees. It is not suggested, however, that education has been virtually at a standstill since these recommendations were made. Much progress has indeed been made.

The teaching of science in secondary schools is subjected to much constructive criticism in the report. A plea is put forward for a more intimate alliance between subjects, provided the essential autonomy of each is preserved. It is clear, too, that certain scientific subjects are needlessly subdivided. Advantage should also be taken of the inherent curiosity of children about the practical concerns and activities of the world to bring their studies into closer contact with the practical affairs of life. This is best done by making the curriculum more general and freer, and most will agree with Dr. H. A. L. Fisher that is all to the good. The Spens Committee is thus led to urge strongly the claims of general science to a place in secondary school education.

The Committee considers that the teaching of science has lost touch with life itself, and for this reason has often failed either to give knowledge required or to stimulate the pupils' interest. This supports the pleas made by Sir William Bragg, in his presidential address to the Science Masters' Association in 1936, for the teaching of science in ways that will facilitate co-operation in dealing with national and international affairs—a strong plea in face of the present-day challenge to democracy.

There can be little doubt that in the early educative period more generalized science teaching is required. This was agreed so far back as 1934 at a conference arranged by the Science Masters'

* Report of the Consultative Committee on Secondary Education with Special Reference to Grammar Schools and Technical High Schools. Pp. xxviii+475. (London: H.M. Stationery Office, 1939.) 3s. 6d. net.

Association and the Institute of Education of the University of London. There the inclusion of biology in the syllabus was urged, which led Prof. E. N. da C. Andrade to admit that such a wider syllabus might lead to some superficiality of treatment, but he could see no particular harm in that—a statement of greater significance perhaps now than then. The interim report of the sub-committee appointed by the Science Masters' Association to consider the question of general science was much in favour of teaching the subject, and we commented (see NATURE, **138**, 1030; 1936) on the efforts being made to change school science from its traditional, intensive and formal habit to a broader and more human shape. The addition of biology to a curriculum hitherto containing physics and chemistry only must of necessity broaden the cultural aims of science teaching. A general syllabus containing all three subjects aims, as no narrower syllabus can, at helping the pupil towards an intelligent understanding of his immediate environment, and thus forms a sounder basis for widening his interests and understanding in later life.

The Spens report emphasizes all this very thoroughly, and goes so far as to say that, in boys' schools especially, science teaching is too often restricted to the physical sciences, and in girls' schools too much botany is taught at the expense of biology. It is, therefore, of interest to compare the number of candidates in England and Wales offering these subjects in the School Certificate examinations in 1933 with those of 1937. In 1933, 27,007 candidates offered chemistry; in 1937, the number was 27,246—a negligible increase; physics has shown an increase from 18,860 to 20,826; botany a decrease from 13,094 to 8,487; biology an increase from 6,171 to 15,119; and general science an increase from 2,560 to 4,779. Although the period taken is comparatively short, it seems, therefore, that the recommendations made by various bodies in the past few years are bearing fruit. So this augurs well for the Spens report.

The report goes still further, however, in its recommendation that science should be more generalized. It suggests that astronomy and possibly some geology should be included; while in chemistry, a certain amount of attention should be given to organic studies. There seems no sound argument against such recommendations, which should have the whole-hearted support of every educationist and man of science. It is interesting to note, too, that the final report of the sub-committee of the Science Masters' Association*, recently issued, puts forward similar views.

The Spens report gives special consideration to the peculiar problems of the country secondary schools, asserting that full advantage should be taken of their rural environment. The report recommends the teaching of more biology, agriculture, gardening and so forth, and the application of local surveys and farm statistics to geography and mathematics. The special position of a rural school is so obvious that to take advantage of the resources of the countryside seems a natural sequence. As optional subjects, the final report of the Science Masters' Association also recommends more biology, ecology, gardening and agriculture. While agreeing in principle with these conclusions, we suggest that they be treated with a certain amount of caution. The immediate environment of the rural school is naturally an advantage and convenience for the teacher. But more important than this is consideration for the future of the taught. Carried to ill-considered extremes, these recommendations would involve a 'rural population' receiving a rural education, and an 'urban population' a non-rural education. But there are children in the country more talented in the physical sciences, and the reverse applies to certain town children. Physics, chemistry and astronomy can and should be taught equally in both types of school; and in the town school, experimental biology can be taught, though of course not with such a wealth of material at hand as in the rural school. Few town children of to-day are absolutely unfamiliar with country life, or at any rate with plant and animal life, including man. While supporting the suggestion, therefore, that the school should take advantage of its environment, we would plead for a certain balance and plasticity in the individual school curriculum, in order to prevent the production of a certain number of 'square pegs in round holes'.

As we have stated over and over again, the narrowness of school science is due in no mean measure to the stranglehold of examinations. This applies especially to the School Certificate examination, which is the subject of criticism in the Spens and Science Masters' Association reports. At present, it tends to enforce an undesirable

* "The Teaching of General Science". Part 2. The Science Masters' Association. (London: John Murray, 1938). 2s. 6d.

uniformity in the curriculum, especially through its group system. The abolition of this grouping was recommended by the Secondary Schools Examination Council (Circular 1463, H.M. Stationery Office). This is now endorsed by the Spens Committee, and certain examining bodies have decided to adopt the recommendation. Such a recommendation will relieve the pupil from forced issues and encourage him more to follow his own bent. It is, for this reason, to be hoped that the recommendation will eventually be adopted by all examining bodies. Furthermore, both reports plead for a consideration of school records supplied by those who have taught the candidates. We welcome this suggestion, since it would relieve the examiners of what is tantamount to absolute authority in assessing educational merit, for which everyone, and especially the examiners themselves, would feel grateful.

It is gratifying to note that in the House of Commons on February 2, the Parliamentary Secretary to the Board of Education stated, in reply to a question, that the Spens report is being examined departmentally, and that "no time will be lost in getting into touch with local education authorities and other interested parties for the purpose of a full discussion of the important and constructive recommendations on such matters, among others, as technical high schools, the curriculum of grammar schools, the school certificate examination, and the inspection of private schools".

The recommendations enumerated above, even if only adopted in part, are bound to have their repercussions on the teacher as well as on the pupil. This is an important aspect of the problem which the Science Masters' Association report seems to have taken more to heart than has the Spens report. It is axiomatic that the right kind of teacher is required—one with a 'generous' training in science rather than the narrow specialist. Many teachers in secondary schools are university graduates who have specialized in one or two subjects. They would naturally feel embarrassed on being asked to teach subjects with which they are not familiar. In fact, according to the Science Masters' Association report, some of them are not in favour of general science for this reason. But that is merely shelving the problem. In any event, there is, as stated in this report, a tendency to exaggerate the difficulty, and the same report offers suggestions to such specialized teachers. There are, for example, Board of Education studentships to enable teachers to improve their qualifications, university diplomas in certain subjects, evening courses in universities and colleges, vacation courses and so forth. There are also other facilities; for example, the Educational Advisory Board of the British Social Hygiene Council is offering a course for teachers in biology.

But these, at their best, can only help present-day teachers, and not even all those. It is the teacher of the future who will have to face the problem in its entirety. It is, therefore, the responsibility of the authorities to see that the most suitable teachers are available to deal with changes in educational curricula and methods. Most committees dealing with the problem look solely to the universities for aid and inspiration. But it is not the main function of a university to produce school teachers, although one cannot justifiably accuse them of being blind to the needs of the teaching profession. Much could be done before the future teacher makes his final choice of degree work. It is difficult, for example, to see the necessity for so many honours graduates in schools. A teacher with a general degree has, at any rate, sufficient actual knowledge of his subjects for school-teaching purposes, and more of them.

It is, we think, to the training colleges and education departments of the universities from which help might also be expected. Certain of them are already making efforts to produce the kind of teacher required to meet the changes in educational method. The education department of the University of Reading, for example, already offers a course on the teaching of rural science to graduates in science, agriculture and horticulture (see p. 305). This policy could, we think, with advantage be extended in such training institutions to the teaching of general science. Many student teachers enter their period of teacher-training either concurrently with their reading for a degree or after having graduated. They have already, therefore, a certain knowledge of scientific method and outlook, and should be easy material for elementary instruction in other scientific subjects and in general scientific methods. In this way, teachers with the requisite knowledge of general science could be supplied to the schools —teachers infinitely better equipped to teach general science than the first-class honours man who, in order to teach it competently, is forced to devote his spare time to extra courses of instruction after his period of training.

Science in the Modern World

The Social Function of Science

By J. D. Bernal. Pp. xvi+482. (London: George Routledge and Sons, Ltd., 1939.) 2*s*. 6*d*. net.

FOUR years ago a series of essays under the title "The Frustration of Science", to which Prof. J. D. Bernal himself contributed one on "Science and Industry", bore witness to the sense of social responsibility of individual scientific men at least, and to their concern at tendencies or forces which are preventing science from bringing its full benefits to mankind. Somewhat earlier, in "Scientific Research and Social Needs", Prof. Julian Huxley gave a popular picture of the extent to which scientific advance is influencing every aspect of everyday life and a brief forecast of some of the further possibilities if we can lessen or close the wide gap still existing between scientific knowledge and its application to the needs of humanity. In the interval, Lord Stamp in "The Science of Social Adjustment" has outlined something of a programme for research on some of the urgent problems arising from the impact of science on society. The events in the year or more since the publication of the present volume was first announced have made it, if anything, even more timely. Besides the more widespread interest in the reaction of science on society and the social consequences of scientific discoveries, scientific workers have become aware that, for the first time since the Renaissance, science itself is in danger, and that political forces are threatening not merely the direction but even the existence of science.

"The Social Function of Science" is fundamentally an elaboration of the books mentioned above. Addressed primarily to scientific workers in general, it ranges over the whole field of science, and indicates broadly its present position and structure, and the way in which the advance or the application of science is being delayed. It gives also some idea of the possibilities if the limitations or impediments to that advance or application can be removed, and like Lord Stamp, from whose book he quotes extensively, Prof. Bernal makes a number of specific proposals for investigation with the view of eliminating existing handicaps or obstacles.

The task Prof. Bernal has set himself is encyclopædic; but he is to be congratulated alike on the width and balance of his survey. Important as detail may be, he has not allowed it to obscure his main theme, which is to give a comprehensive picture of the whole situation. This he considers is the first condition of real progress. The present unsatisfactory position is largely due to lack of such a comprehensive view, and to the pursuit of short-range or sectional policies which may hinder the general advance. One of the main points in Prof. Bernal's argument is indeed the intricacy or complexity of the situation. Scientific advance in a particular field is determined not merely by the ability and number of the workers in that field, the way they are organized and the resources at their disposal, but also by their relations with the general body of men of science as well as by their whole social, industrial and political environment. He argues that attention to the social functions of science is required in the interests of scientific advance as well as in the interests of society.

Nor is this a new point of view. The social function of science is something which has grown up imperceptibly with science itself and in the same haphazard and unco-ordinated manner. This forms the theme of the second chapter of the book, which gives a concise but adequate historical approach. From this, the author proceeds to discuss the main structure of science at the present time. The existing organization of scientific research in Great Britain, both academic and industrial, the place of science in education and the training of the scientific worker, factors which limit the efficiency of research at the present time are reviewed, as well as the very topical questions of science and war and international relations of science.

Prof. Bernal makes many shrewd comments on present-day weaknesses and causes of inefficiency which individual scientific workers will be able to endorse from their own experience, if the author himself is limited rather to generalities. Moreover, while Prof. Bernal is a keen critic of many conditions for which scientific workers themselves have at most only an indirect responsibility, he leaves no room for doubt that there are many problems to which they could give their immediate attention, and that if science is to be of full use to society it must first set its own house in order.

The second part of the book gives Prof. Bernal's view of the possibilities which science offers if these limitations on its efficiency and utilization were removed. A series of chapters, which are largely the counterpart of those in the

first part of the book, contain his own constructive suggestions in such matters as the training of the man of science, the reorganization of research, scientific communications, or publications, the finance of science and the strategy of scientific advance, and finally a picture of how science would be utilized in a beneficent transformation of human economy.

It is impossible in the space of a short review even to mention the main topics upon which Prof. Bernal touches. His chapters are calculated to stimulate thought and discussion, and if the plan of the book necessitates those interested in one particular topic, such as education or scientific publications, turning from one chapter to another widely separated in the second part of the book, instead of being able to follow it continuously, the arrangement undoubtedly serves the main purpose of the book. Whether in discussing such particular topics or in dealing with the general situation, Prof. Bernal rarely fails to touch on the fundamental problems. Even to scientific workers in their own particular field he often suggests new possibilities or points of view; but the treatment is never allowed to degenerate into disconnected discussions which are unrelated to the main problem of the future of science and its ability to serve society.

Prof. Bernal regards the present social disorders as primarily due to science progressing beyond the social forms in which during the last five hundred years it has developed. The future of science depends on the creation of a new social form and demands the intelligent management of science by society as a whole. Accordingly he argues that scientific workers cannot be indifferent to politics and must avoid becoming pawns of the major social forces, although he does not believe that as men of science they should join any particular party.

Some minor criticisms may be offered. The book bears some evidence of hasty writing. Some quotations are repeated *in extenso* where a reference might easily have served. The appendix on expenditure on industrial research might well have been omitted. A table which omits the names of firms pre-eminent in industrial research at the present time and representing a total expenditure of less than £120,000 per annum on research in Great Britain is too misleading to give even a rough idea of the situation. Again, the account of Soviet science and the development of a scientific outlook in the U.S.S.R. would have gained in value by some indication as to whether or not the greater use of science under that regime is accompanied by any greater freedom of direction and content of scientific investigation than under Fascism. The section on associations of scientific workers is rather unbalanced and is strangely free from Prof. Bernal's usual pertinent and constructive criticism. He omits all reference to A. M. Carr-Saunders and P. A. Wilson's fine study of this problem, and one is inclined to suspect that Prof. Bernal himself is among the many scientific workers who have overlooked the significance of that study.

These and other points, however, are minor matters. Some may well be rectified in a later edition, and meanwhile, at a time when the personal security which has formerly been one of the chief triumphs of civilization has diminished almost to vanishing point, scientific workers may well be grateful for this well-balanced analysis of the intricate relations between science and contemporary life and its constructive proposals to remedy the mistakes and failures of the past. At least, it is to be hoped this book will not, like so many other constructive and suggestive works in recent years, be ignored by their professional associations.

R. BRIGHTMAN.

Nutritional Science

Science and Nutrition

By A. L. Bacharach, with a Preface by Prof. J. C. Drummond. (Changing World Library, No. 11.) Pp. xiv+154. (London: C. A. Watts and Co., Ltd., 1938.) 2*s*. 6*d*. net.

THIS is a book with a flavour all its own. The author himself modestly defines his aim as being to "put before the reader the kind of methods used in the laboratory study of nutritional problems and the kind of knowledge obtained thereby". That he has succeeded admirably in this there can be no doubt. But he has done a good deal more as well. The book resembles neither the ordinary 'elementary science primer' on one hand nor the usual type of 'popular science for the layman' on the other. It puts one in mind rather of a series of essays, discursive, stimulating, witty, such as one might expect to find in one of the weekly literary or political reviews. With no sacrifice of accuracy, the text is enlivened by the catholic tastes as well as by the stylistic gifts of the author. It is for this reason that Mr. Bacharach's little book will be read with so much entertainment and

profit not only by the man in the street to whom, as he tells us, it is principally addressed, but also by the specialist.

In the introduction a justification is given for the predominantly chemical treatment which the subject is accorded :

"Walter Pater said that all art aspires towards the nature of music ; is it not also true to say that all biology aspires towards interpretation in terms of atomic physics ? It will probably be conceded that chemical interpretations are a little nearer to the physical asymptote than are physiological. If so, the urgent need to guide the layman away from the mists of obscurantism—naturalism, vitalism, and what not—in his application of scientific knowledge to ordinary human and social problems, must surely justify the presentation to him of biological facts in terms as far removed as possible from the dangers of mystification. I honestly believe that there is a better chance of doing this on the chemical than on the physiological plane."

It might be argued that this reasoning is somewhat stiff going for the 'man in the street' aforementioned, as are also for example such technical points as the chemical equation for the esterification of mixed glycerides (p. 31), or the statement (p. 142) that "the requirements of the population as a whole will presumably be distributed about M/N, in accordance with the normal frequency distribution curve, though nothing at all is known about the breadth or steepness of the curve that indicates the normal variations in need for this or for any other dietary essential". But this objection cannot be sustained, because it is explained (p. ix) that it is for the "interested *and educated* layman" that the book has been written ; and its author has also assumed (p. 11) that—

"the reader may well be already acquainted with the general features of human nutrition—the broad chemistry of carbohydrates, fats, and protein, the kinds of food in which they occur and their relative amounts, the processes of breaking down—catabolism—to simpler constituents and building up again—anabolism—to the more complex substances of the living body, the two processes together constituting the *metabolism* of the organism."

Incidentally, another justification offered for the essentially chemical approach is that the lay reader is more likely to be acquainted with chemistry than with biology. "The chances, alas, that he will ever have been instructed even in the earliest rudiments of animal physiology are still to-day so small as to be negligible." Fortunately, biology is to-day being given increasing recognition in the average school syllabus, and it may be that in a few years time this reproach will no longer be valid.

As Mr. Bacharach is largely concerned with describing the results of investigations in the laboratory, "particularly with experiments on small animals", it was a happy touch to dedicate his book (in impeccable Latin phrases) to the albino rat. An introductory chapter is devoted to a justification, and a very persuasive one, of the use of laboratory animals—not as a substitute for clinical studies, but as "biological reagents".

Following on this introduction, the second section of the book deals with "Classical Nutritional Science", that is, with carbohydrates, fats and proteins. Next is a treatment of the mineral elements, "major" as well as "trace", and of hormones. After this we are given an account of the vitamins. In this portion the author makes no pretence to deal even in outline with the whole field, but wisely contents himself with a series of illustrative examples—vitamin A serves to show how vitamins are detected, vitamin C how they are measured, and D how they have been identified.

The final portion of the book deals with diet and human health, first with "the necessity for the optimal", and then—coming down to earth—with the "absence of the optimal". This last aspect of the problem could not be better summed up than as it is by Prof. J. C. Drummond in his most attractively written preface :

"The survival of democracy or its annihilation during the next few years may easily be determined by the measure of attention given in the various countries to what have come to be called the problems of human nutrition. . . . The great majority of the 'problems of nutrition', about which one hears so much nowadays, have been solved by the scientist, and they are now translated into problems of economics or political science. . . . The incidence of pellagra in the 'corn-belt' of the United States still sharply reflects the rise and fall of poverty and unemployment. It is not a question of nicotinic acid ; it is simply one of £. s. d. The only real problem of nutrition in England to-day is the task of making available to the poorest person the 'protective foods', such as milk, butter, fresh salads, and fruit, which are essential for health."

Referring to so-called 'minimal' diets, Mr. Bacharach adds a much-needed corollary. "When a constructional firm is asked to tender for a railway bridge, it is asked to tender for a railway bridge that will do its job as well as possible, and not for one that will be just 'safe' or 'minimal' within the financial ability of the customer to pay. It seems unfortunate that, in matters of human construction, a different principle should be adopted."

LESLIE J. HARRIS.

The Air Almanac

The Air Almanac, 1939, January–March (Air Publication 1602.) Prepared by H.M. Nautical Almanac Office on behalf of the Air Ministry. Pp. 188+xii. (H.M. Stationery Office, 1938.) 5s. net.

THE British "Air Almanac", an almanac specially adapted to the requirements of air navigation, was published for the first time for the last quarter of the year 1937. A review of this publication appeared in these pages. Experience with the almanac in its original form showed the desirability of certain changes. These changes were required, in the first place, in order to shorten the time occupied in working out the results, and, in the second place, to reduce the amount of turning over of pages, because the air navigator often has very cold fingers. Another consideration was the numbing effect on the brain of a long flight; in order to reduce the possibility of error, it was desirable to make the working out of the results so far as possible a matter of pure routine. To meet these requirements, the "Air Almanac" has been completely remodelled. As compared with the original almanac, in the remodelled edition the amount of interpolation has been reduced to a minimum: the number of separate tables that have to be referred to has been reduced, so avoiding turning over pages; and the way of extracting the required information has been standardized.

It may be recalled that the quantities tabulated in the "Air Almanac" are the Greenwich hour angle expressed in arc (that is, the hour angle measured from the meridian of Greenwich) and the declination. These are the two quantities that are required for drawing a position line. For the stars the simplification is introduced of tabulating the Greenwich hour angle of the First Point of Aries. To obtain the Greenwich hour angle of a star, the sidereal hour angle of the star (the hour angle measured westwards from the First Point of Aries) must be added to the Greenwich hour angle of the First Point of Aries. The sidereal hour angle of a star is a quantity that varies slowly through the year and, to the degree of accuracy of tabulation employed in the "Air Almanac", can be taken as constant for the period of three months covered by each issue of the Almanac in its new form.

In the new issue of the Almanac, the intervals of tabulation have been reduced for the sun, moon and planets. The data for the sun and moon, formerly given at hourly intervals, are now given at intervals of ten minutes; the data for the planets, formerly given at intervals of six hours, are now given at hourly intervals. The interpolations required for the extraction of the data for a given instant of time are accordingly much reduced and simplified. The original publication consisted of a permanent portion containing interpolation and other tables, together with explanation and description, and ephemeral loose-leaf sheets, each one of which contained the data for two days, the stars on one side and the sun, moon and planets on the other. These two portions have now been combined, so that each quarterly issue in the new form is self-contained.

The reduction in the intervals of tabulation has necessitated doubling the number of pages, so that each sheet now caters for one day only. The sheets are perforated and can be torn off in succession as they cease to be required. The increase in size of the Almanac has made possible the tabulation of sunrise, sunset, twilight, moonrise and moonset for each day. The parallax in altitude of the moon is tabulated for each day in the form of a critical table and the phase of the moon is also given. The planetary data are restricted to the three planets that are most favourably placed for observation. The arrangement of the data has been considered very carefully and the maximum possible information has been given in the space available, but without any appearance of undue crowding.

The introduction and explanation of the use of the tables is given after the daily sheets. The list of stars (fifty in all), together with magnitudes, sidereal hour angles and declinations, and an interpolation table for the interpolation of the Greenwich hour angles of the First Point of Aries and of the sun, are given inside the front cover. Space is provided also for a table of dome refractions, for use when observations are made through a dome. A flap is provided which gives the interpolation tables for the Greenwich hour angle of the moon and of the planets and for moonrise and moonset, as well as the Pole Star table and a table for the conversion of arc into time.

Of the various Air Almanacs that have been published, this Almanac in its remodelled form is undoubtedly the most convenient and compact. The Nautical Almanac Office, which has undertaken the computation of the Almanac for the Air Ministry, by agreement with the Admiralty, is to be congratulated on an excellent production, and the Stationery Office deserves to be complimented on a clearly printed and well-bound volume.

It may be added that the tabulated data, given to the nearest minute of arc, are sufficiently accurate for most requirements of surface navigation.

Man in a Chemical World:
the Service of Chemical Industry. By A. Cressy Morrison. Pp. xii+292. (London: Scientific Book Club, n.d.) 2*s*. 6*d*.

THIS volume is an interesting example of the publications of the Scientific Book Club, which are available to members at the uniform price of half-a-crown. Described as "a straight-from-the-shoulder account of the activities of chemical industry in converting the discoveries of science into day-to-day necessities of Everyman", it was originally produced under the auspices of the Executive Committee of the American Chemical Industries Tercentenary, in connexion with the celebration in 1935 of the three-hundredth anniversary of the birth of chemical industry in the United States. Its object, as explained in a foreword, "is to impress the man in the street with the fact that the chemical industries of the United States render a service that touches practically every activity in which he engages". This object is amply attained in a simple and able account of the multifarious achievements of chemistry in industry and everyday life, set out under such headings as "Nature Points the Way", "Chemistry in Overalls", "Keeping Well", "Feeding Millions", "From Papyrus to Television", etc.

A remarkable amount of interesting information has been packed, in an attractive form, into this low-priced volume. The language is plain, and there are no chemical formulæ to puzzle the lay reader. The text is well printed in a bold type by the Scribner Press in the United States. There are a few ingenious pictorial diagrams; but some of the illustrations are neither instructive nor decorative. J. R.

Die tierischen Parasiten des Menschen
Von Prof. Walter Stempell. Pp. viii+226. (Jena: Gustav Fischer, 1938.) 12 gold marks.

IN a more convenient and compact form than has hitherto appeared in Germany, this work essays the description of the parasitic fauna of man. Morphological characters are summarized clearly and briefly, but with sufficient detail for identification of all the common parasites. But the rarer forms are also represented (more briefly and in small type) as may be judged by the inclusion of the python parasite *Armillifer moniliformis*, with five cases recorded from man, and of several insects the connexion of which with human disease is slight; in all, 192 parasites are described. A special feature is the illustration of the text by original schematic figures, which are often accompanied by corresponding photographs.

Since the book is intended to be of service to general zoologists rather than to specialists, morphology takes precedence over physiological, biological, medical and epidemiological aspects, and these are seriously touched upon only in the case of prominent forms, like *Plasmodium*, *Trypanosoma*, the tapeworms and a few arthropods. The publishers are to be congratulated on the clearness of the printing and reproduction of illustrations. *Wucheria* (pp. 134, 135 and index) should be *Wuchereria*.

Insects of Citrus and other Subtropical Fruits
By Prof. Henry J. Quayle. Pp. x+583. (Ithaca, N.Y.: Comstock Publishing Co., 1938.) 5 dollars.

THE field covered by this work is an extensive one which has not been previously dealt with in a comprehensive book form. Its author has had wide experience of citrus fruit cultivation, and its insect enemies, not only in California but also in other lands. While the book deals with all the main citrus-affecting insects, other subtropical fruit insects are also included, notably those affecting avocado, Persian walnut, vinifera grape, fig, almond, olive, date and some others. The life-histories of the chief pests are described and usually figured. Their natural enemies, where noteworthy, are discussed, and artificial methods of control are fully entered into. The subject matter of this book is up-to-date while the illustrations are often new and original. It is a work that is to be recommended to all concerned with citrus cultivation and more particularly to growers in the United States.

Japanese Minerals in Pictures
By T. Ito. In 4 vols. Vol. 1. Pp. xiv+152+27 plates. (Tokyo: The Author, Tokyo Imperial University, 1937.) 12 yen.

A VERY handsomely illustrated mineralogy with the text in Japanese is Prof. Takeo Ito's "Japanese Minerals in Pictures", of which the first of the four volumes was published in Tokyo in 1937. In 152 pages with 96 crystal drawings the elements, sulphides, and fluorides are described. A fourteen-page key in English gives a brief account of the 38 minerals depicted in the 27 plates, with brief notes on the chief occurrences of the minerals in Japan. Twenty of the plates are reproduced in colour and some of these are among the best coloured representations of minerals printed hitherto. The specimens illustrated are picked specimens and will be the envy of mineral collectors. These plates are the special features of the book and will earn it a place on the shelves of mineralogical libraries all over the world.

Useful Trees and Shrubs:
Being a Card File of Data on approximately 500 Hardy Woody Plants in Common Use as Ornamentals. Compiled and prepared by Prof. Florence Bell Robinson. 494 Cards. 6 in. × 4 in. (Champaign, Ill.: The Garrard Press, 1938.) 4.50 dollars.

THIS card index will be useful to those interested in hardy shrubs and trees, though it is difficult to see that it has any advantage over the available books as a reference work. Certain blank spaces on the cards are said to be an invitation to the user to add his own observations and sketches; if used in this way there is no doubt that much benefit would accrue to the user, and in this case the card index scheme admits of profitable expansion of the record. Notes on the cards refer to habitat; form; colour; bark; season of foliage; flower and fruit; 'cleanliness' (that is, susceptibility to pest and disease); pruning; aspect and value.

Fluorescence and Phosphorescence

By Dr. E. Hirschlaff. (Methuen's Monographs on Physical Subjects.) Pp. vi+130. (London: Methuen and Co., Ltd., 1938.) 3*s*. 6*d*. net.

THIS new addition to Methuen's series of monographs on physical subjects makes a valiant attempt to cope with the whole of the subject of luminescence, a task particularly difficult at the present time in view of the rapid advances taking place. The book may, on the whole, be recommended to the general reader. Those already familiar with the subject are likely to discover a number of inadequacies. One feels that the directions of most rapid progress at the present time have not been sufficiently emphasized, and it might have been a good deal wiser to confine the book to one of the more important aspects of the subject. In the result there are twelve chapters, of which the first and last are the worst. Chapter i, subtitled "The Experiments", is almost meaningless in its narrow limits of three pages. Such "experiments" as are here mentioned could easily have been brought naturally into line in the later sections of the book. Chapter xii is concerned with technical applications. The most important application of luminescent solids is in discharge devices, and Dr. Hirschlaff's treatment of this aspect cannot be considered as more than sketchy.

The emphasis of the book may be gathered from the fact that seven of the chapters are given up to the problems of fluorescence in gases, liquids and solutions. Two chapters deal specifically with luminescence in solids, and there is also an account of 'cathodo-luminescence'. It is a pity that the references to original papers given at the foot of each chapter are almost entirely confined to Continental workers. J. T. R.

Hydroids of the Pacific Coast of Canada and the United States

By C. McLean Fraser. Pp. 208+44 plates. (Toronto: University of Toronto Press, 1937). 2.50 dollars.

TO open this book is to be at once reminded of Hincks' "Hydroid Zoophytes", now seventy years old, or of Dr. George Johnston's book of a generation before, both of them beloved by innumerable naturalists. Here, in like manner, Prof. McLean Fraser has produced, in handy form and copiously illustrated, an account of the rich hydroid fauna of the Pacific Coast, from California all the way to Bering Sea. We are struck, at first sight, by the curious likeness of this fauna to the British fauna; many species are identical, such as Linnæus's *Obelia geniculata* and *Sertularella polyzonias*, or Ellis and Solander's *Halecium muricatum*. Others, not so familiar as these, such as the various species of *Selaginopsis*, carry an Arctic fauna round the world from the Murman Coast and the Siberian Sea. But there are not wanting many others, strange to our European seas. The book is an interesting one to the naturalist at home, and will become an indispensable one to the many naturalists out west by the Pacific. D. W. T.

A Hand through Time:

Memories—Romantic and Geological; Studies in the Arts and Religion; and the Grounds of Confidence in Immortality. By Dr. Edward Greenly. Vol. 1. Pp. xvi+378+60 plates. Vol. 2. Pp. viii+379–774+15 plates. (London: Thomas Murby and Co., 1938.) 18*s*. net.

DR. EDWARD GREENLY is best known as the author of a comprehensive memoir on the geology of Anglesey and of a geological map of that island, both published by the Geological Survey. Practically the whole of his long life has been devoted to geological research and, during his wife's lifetime, he owed much to her helpful co-operation. A large part of his book is devoted to a character study of Mrs. Greenly, with which is interwoven the author's autobiography. This account of a long life's companionship will interest especially Greenly's wide circle of friends and acquaintances.

The book is somewhat discursive, but it includes a chronicle of its author's scientific activities, and there are many interesting geological reminiscences. Dr. Greenly's career as a geologist commenced in Scotland in 1889, where he was attached to the Geological Survey for a few years. There he came into contact with Peach, Horne, Clough and other geologists of the period, and he gives an interesting account of survey work in Scotland at that time. On leaving the Survey he proceeded to Anglesey, where he spent twenty years unravelling the complex geology of that island. The account of this masterly piece of research should prove of interest to all geologists, whether or not they are acquainted with its author.

Physical Geography for Indian Students:

being a completely revised and enlarged edition of Simmons and Stenhouse's "Class-Book of Physical Geography". By Dr. Cyril S. Fox. Pp. xii+564+5 plates. (London: Macmillan and Co., Ltd., 1938.) 7*s*. 6*d*.

ALTHOUGH primarily intended for Indian students, this revised edition of a well-known text-book makes a wider appeal. The coloured maps which illustrate various aspects of map reading have been chosen from the Survey of India, and many of the examples of physical processes have been chosen from India, but the book as a whole covers all the groundwork of physical geography, including the distribution of climate, plants and animals, and should be useful in all English-speaking lands as an introduction to geography. One of the greatest difficulties confronting the writers of an elementary book on these subjects is the avoidance of over-simplification in the discussion on problems of climate. It is easy to generalize and difficult to avoid complexity. On the whole these pitfalls have been well avoided, but a little revision would not be amiss on the subjects of cyclones, world distribution of atmospheric pressure and ocean currents. On the whole, however, the book is admirable and the many exercises are a valuable feature. R. N. R. B.

Natural Philosophy and Human Cultures*

By Prof. Niels Bohr, For. Mem. R.S.

IT is only with great hesitation that I have accepted a kind invitation to address this assembly of distinguished representatives of the anthropological and ethnographical sciences of which I, as a physicist, have of course no first-hand knowledge. Still, on this special occasion, when even the historical surroundings speak to everyone of us about aspects of life other than those discussed at the regular congress proceedings, it might perhaps be of interest to try with a few words to direct attention to the epistemological aspect of the latest development of natural philosophy and its bearing on general human problems. Notwithstanding the great separation between our different branches of knowledge, the new lesson which has been impressed upon physicists regarding the caution with which all usual conventions must be applied as soon as we are not concerned with everyday experience, may, indeed, be suited to remind us in a novel way of the dangers, well known to humanists, of judging from our own point of view cultures developed within other societies.

Of course it is impossible to distinguish sharply between natural philosophy and human culture. The physical sciences are, in fact, an integral part of our civilization, not only because our ever increasing mastery of the forces of Nature has so completely changed the material conditions of life, but also because the study of these sciences has contributed so much to clarify the background of our own existence. What has it not meant in this respect, that we no more consider ourselves as privileged in living at the centre of the universe, surrounded by less fortunate societies inhabiting the edges of the abyss, but that through the development of astronomy and geography we have realized that we are all sharing a small spherical planet of the solar system, which again is only a small part of still larger systems. How forceful an admonition about the relativity of all human judgements have we not also in our days received through the renewed revision of the presuppositions underlying the unambiguous use of even our most elementary concepts such as space and time, which, in disclosing the essential dependence of every physical phenomenon on the point of view of the observer, has contributed so largely to the unity and beauty of our whole world-picture.

While the importance of these great achievements for our general outlook is commonly realized, it is scarcely yet so as regards the unsuspected epistemological lesson which the opening of quite new realms of physical research has given us in the most recent years. Our penetration into the world of atoms, hitherto closed to the eyes of man, is indeed an adventure which may be compared with the great journeys of discovery of the circumnavigators and the bold explorations of astronomers into the depths of celestial space. As is well known, the marvellous development of the art of physical experimentation has not only removed the last traces of the old belief that the coarseness of our senses would for ever prevent us from obtaining direct information about individual atoms, but has even shown us that the atoms themselves consist of still smaller corpuscles which can be isolated and the properties of which can be investigated separately. At the same time we have, however, in this fascinating field of experience been taught that the laws of Nature hitherto known, which constitute the grand edifice of classical physics, are only valid when dealing with bodies consisting of practically infinite numbers of atoms. The new knowledge concerning the behaviour of single atoms and atomic corpuscles has, in fact, revealed an unexpected limit for the subdivision of all physical actions extending far beyond the old doctrine of the limited divisibility of matter, and giving every atomic process a peculiar individual character. This discovery has, in fact, yielded a quite new basis for the understanding of the intrinsic stability of atomic structures, which, in the last resort, conditions the regularities of all ordinary experience.

How radical a change in our attitude towards the description of Nature this development of atomic physics has brought about is perhaps most clearly illustrated by the fact that even the principle of causality, so far considered as the unquestioned foundation for all interpretation of natural phenomena, has proved too narrow a frame to embrace the peculiar regularities governing individual atomic processes. Certainly everyone will understand that physicists have needed very cogent reasons to renounce the ideal of causality itself: but in the study of atomic phenomena we have repeatedly been taught that questions which were believed to have received long ago their final answers had most unexpected surprises in store for us. You will surely all have heard about the riddles regarding the most elementary

* Address given at Kronborg Castle during the excursion to Elsinore of the International Congress of Anthropological and Ethnological Sciences, Copenhagen, August, 1938.

properties of light and matter which have puzzled physicists so much in recent years. The apparent contradictions which we have met in this respect are, in fact, as acute as those which gave rise to the development of the theory of relativity in the beginning of this century, and have, just as the latter, only found their explanation by a closer examination of the limitation imposed by the new experiences themselves on the unambiguous use of the concepts entering into the description of the phenomena. While in relativity theory the decisive point was the recognition of the essentially different ways in which observers moving relatively to each other will describe the behaviour of given objects, the elucidation of the paradoxes of atomic physics has disclosed the fact that the unavoidable interaction between the objects and the measuring instruments sets an absolute limit to the possibility of speaking of a behaviour of atomic objects which is independent of the means of observation.

We are here faced with an epistemological problem quite new in natural philosophy, where all description of experiences has so far been based upon the assumption, already inherent in ordinary conventions of language, that it is possible to distinguish sharply between the behaviour of objects and the means of observation. This assumption is not only fully justified by all everyday experience, but even constitutes the whole basis of classical physics, which, just through the theory of relativity, has received such a wonderful completion. As soon as we begin to deal, however, with phenomena like individual atomic processes which, due to their very nature, are essentially determined by the interaction between the objects in question and the measuring instruments necessary for the definition of the experimental arrangements, we are forced to examine more closely the question of what kind of knowledge can be obtained concerning these objects. In this respect we must, on one hand, realize that the aim of every physical experiment—to gain knowledge under reproducible and communicable conditions—leaves us no choice but to use everyday concepts, eventually refined by the terminology of classical physics, not only in all accounts of the construction and manipulation of the measuring instruments but also in the description of the actual experimental results. On the other hand, it is equally important to understand that just this circumstance implies that no result of an experiment concerning a phenomenon which, in principle, lies outside the range of classical physics, can be interpreted as giving information about independent properties of the object; but is inherently connected with a definite situation in the description of which the measuring instruments interacting with the objects also enter essentially. This last fact gives the straightforward explanation of the apparent contradictions which appear when results about atomic objects obtained by different experimental arrangements are tentatively combined into a self-contained picture of the object.

Information regarding the behaviour of an atomic object obtained under definite experimental conditions, may, however, according to a terminology often used in atomic physics, be adequately characterized as *complementary* to any information about the same object obtained by some other experimental arrangement excluding the fulfilment of the first conditions. Although such kinds of information cannot be combined into a single picture by means of ordinary concepts, they represent indeed equally essential aspects of any knowledge of the object in question which can be obtained in this domain. It is the recognition of such a complementary character of the mechanical analogies by which one has tried to visualize the individual radiative effects which has, in fact, led to an entirely satisfactory solution of the riddles of the properties of light alluded to above. In the same way, it is only by taking into consideration the complementary relationship between the different experiences concerning the behaviour of atomic corpuscles, that it has been possible to obtain a clue to the understanding of the striking contrast between the properties of ordinary mechanical models and the peculiar laws of stability governing atomic structures which form the basis for every closer explanation of the specific physical and chemical properties of matter.

Of course I have no intention, on this occasion, of entering more closely into such details, but I hope that I have been able to give a sufficiently clear impression of the fact that we are here in no way concerned with an arbitrary renunciation as regards the detailed analysis of the almost overwhelming richness of our rapidly increasing experience in the realm of atoms. On the contrary, we have to do with a rational development of our means of classifying and comprehending new experience which, due to its very character, finds no place within the frame of causal description suited only to account for the behaviour of objects so long as this behaviour is independent of the means of observation. Far from containing any mysticism contrary to the spirit of science, the viewpoint of 'complementarity' forms indeed a consistent generalization of the ideal of causality.

However unexpected this development may appear in the domain of physics, I am sure that many of you will have recognized the close analogy between the situation as regards the analysis of atomic phenomena, which I have described, and characteristic features of the problem of observation

in human psychology. Indeed, we may say that the trend of modern psychology can be characterized as a reaction against the attempt at analysing psychical experience into elements which can be associated in the same way as are the results of measurements in classical physics. In introspection, it is clearly impossible to distinguish sharply between the phenomena themselves and their conscious perception, and although we may often speak of lending our attention to some particular aspect of a psychical experience, it will appear on closer examination that we really have to do, in such cases, with mutually exclusive situations. We all know the old saying that, if we try to analyse our own emotions, we scarcely possess them any longer, and in that sense we recognize between psychical experiences, for the description of which words such as 'thoughts' and 'feelings' are adequately used, a complementary relationship similar to that between the experiences regarding the behaviour of atoms obtained under different experimental arrangements and described by means of different analogies taken from our usual ideas. By such a comparison it is, of course, in no way intended to suggest any closer relation between atomic physics and psychology, but merely to stress an epistemological argument common to both fields, and thus to encourage us to see how far the solution of the relatively simple physical problems may be helpful in clarifying the more intricate psychological questions with which human life confronts us, and which anthropologists and ethnologists so often meet in their investigations.

Coming now closer to our subject of the bearing of such viewpoints on the comparison of different human cultures, we shall first stress the typical complementary relationship between the modes of behaviour of living beings characterized by the words 'instinct' and 'reason'. It is true that these words are used in very different senses; thus instinct may mean motive power or inherited behaviour, and reason may denote deeper sense as well as conscious argumentation. What we are concerned with is, however, only the practical way in which these words are used to discriminate between the different situations in which animals and men find themselves. Of course, nobody will deny our belonging to the animal world, and it would even be very difficult to find an exhaustive definition characterizing man among the other animals. Indeed, the latent possibilities in any living organism are not easily estimated, and I think that there is none of us who has not sometimes been deeply impressed by the extent to which circus animals can be drilled. Not even with respect to the conveyance of information from one individual to another would it be possible to draw a sharp separation between animals and man; but of course our power of speech places us in this respect in an essentially different situation, not only as regards the exchange of practical experience, but also and above all as regards the possibility of transmitting through education to children the traditions concerning behaviour and reasoning which form the basis of any human culture.

As regards reason compared with instinct, it is, above all, essential to realize that no proper human thinking is imaginable without the use of concepts framed in some language which every generation has to learn anew. This use of concepts is, in fact, not only to a large extent suppressing instinctive life, but stands even largely in an exclusive relationship of complementarity to the display of inherited instincts. The astonishing superiority of lower animals compared with man in utilizing the possibilities of Nature for the maintenance and propagation of life has certainly often its true explanation in the fact that, for such animals, we cannot speak of any conscious thinking in our sense of the word. At the same time, the amazing capacity of so-called primitive people to orientate themselves in forests or deserts, which, though apparently lost in more civilized societies, may on occasion be revived in any of us, might justify the conclusion that such feats are only possible when no recourse is taken to conceptual thinking, which on its side is adapted to far more varied purposes of primary importance for the development of civilization. Just because it is not yet awake to the use of concepts, a new-born child can scarcely be reckoned as a human being; but belonging to the species of man, it has, of course, though more helpless a creature than most young animals, the organic possibilities of receiving through education a culture which enables it to take its place in some human society.

Such considerations confront us at once with the question whether the widespread belief that every child is born with a predisposition for the adoption of a specific human culture is really well-founded, or whether one has not rather to assume that any culture can be implanted and thrive on quite different physical backgrounds. Here we are of course touching a subject of still unsettled controversies between geneticists, who pursue most interesting studies on the inheritance of physical characters. In connexion with such discussions, however, we must above all bear in mind that the distinction between the concepts genotype and phenotype, so fruitful for the clarification of heredity in plants and animals, essentially presupposes the subordinate influence of the external conditions of life on the characteristic properties of the species. In the case of the specific cultural

characters of human societies the problem is, however, reversed in the sense that the basis for the classification is here the traditional habits shaped by the histories of the societies and their natural environments. These habits, as well as their inherent presuppositions, must therefore be analysed in detail before any possible influence of inherited biological differences on the development and maintenance of the cultures concerned can be estimated. Indeed, in characterizing different nations and even different families within a nation, we may to a large extent consider anthropological traits and spiritual traditions as independent of each other, and it would even be tempting to reserve by definition the adjective 'human' for just those characters which are not directly bound to bodily inheritance.

At first sight, it might perhaps appear that such an attitude would mean unduly stressing merely dialectic points. But the lesson which we have received from the whole growth of the physical sciences is that the germ of fruitful development often lies just in the proper choice of definitions. When we think, for example, of the clarification brought about in various branches of science by the argumentation of relativity theory, we see indeed what advance may lie in such formal refinements. As I have already hinted earlier in this address, relativistic viewpoints are certainly also helpful in promoting a more objective attitude as to relationships between human cultures, the traditional differences of which in many ways resemble the different equivalent modes in which physical experience can be described. Still, this analogy between physical and humanistic problems is of limited scope and its exaggeration has even led to misunderstandings of the essence of the theory of relativity itself. The unity of the relativistic world picture, in fact, implies the possibility for any one observer to predict within his own conceptual frame how any other observer will co-ordinate experience within the frame natural to him. The main obstacle to an unprejudiced attitude towards the relation between various human cultures is, however, the deep-rooted differences of the traditional backgrounds on which the cultural harmony in different human societies is based and which exclude any simple comparison between such cultures.

It is above all in this connexion that the viewpoint of complementarity offers itself as a means of coping with the situation. In fact, when studying human cultures different from our own, we have to deal with a particular problem of observation which on closer consideration shows many features in common with atomic or psychological problems, where the interaction between objects and measuring tools, or the inseparability of objective content and observing subject, prevents an immediate application of the conventions suited to accounting for experiences of daily life. Especially in the study of cultures of primitive peoples, ethnologists are, indeed, not only aware of the risk of corrupting such cultures by the necessary contact, but are even confronted with the problem of the reaction of such studies on their own human attitude. What I here allude to is the experience, well known to explorers, of the shaking of their hitherto unrealized prejudices through the experience of the unsuspected inner harmony human life can present even under conventions and traditions most radically different from their own. As a specially drastic example I may perhaps here recall the extent to which in certain societies the roles of men and women are reversed, not only regarding domestic and social duties but also regarding behaviour and mentality. Even if many of us, in such a situation, might perhaps at first shrink from admitting the possibility that it is entirely a caprice of fate that the people concerned have their specific culture and not ours, and we not theirs instead of our own, it is clear that even the slightest suspicion in this respect implies a betrayal of the national complacency inherent in any human culture resting in itself.

Using the word much as it is used, in atomic physics, to characterize the relationship between experiences obtained by different experimental arrangements and capable of visualization only by mutually exclusive ideas, we may truly say that different human cultures are complementary to each other. Indeed, each such culture represents a harmonious balance of traditional conventions by means of which latent potentialities of human life can unfold themselves in a way which reveals to us new aspects of its unlimited richness and variety. Of course, there cannot, in this domain, be any question of such absolutely exclusive relationships as those between complementary experiences about the behaviour of well-defined atomic objects, since scarcely any culture exists which could be said to be fully self-contained. On the contrary, it is well known from numerous examples how a more or less intimate contact between different human societies can lead to a gradual fusion of traditions, giving birth to a quite new culture. The importance in this respect of the mixing of populations through emigration or conquest for the advancement of human civilization need scarcely be recalled. It is, indeed, perhaps the greatest prospect of humanistic studies, to contribute through an increasing knowledge of the history of cultural development to that gradual removal of prejudices which is the common aim of all science.

As I stressed in the beginning of this address, it is, of course, far beyond my capacities to contribute in any direct way to the solution of the problems discussed among the experts at this congress. My only purpose has been to give an impression of a general epistemological attitude which we have been forced to adopt in a field as far from human passions as the analysis of simple physical experiments. I do not know, however, whether I have found the right words to convey this impression, and before I conclude, I may perhaps be allowed to relate an experience which once most vividly reminded me of my deficiencies in this respect. In order to explain to an audience that I did not use the word 'prejudice' to imply any condemnation of other cultures, but merely to characterize our necessarily prejudiced conceptual frame, I referred jokingly to the traditional prejudices which the Danes cherish with regard to their Swedish brothers on the other side of the beautiful Sound outside these windows, with whom we have fought through centuries even within the walls of this castle, and from contact with whom we have, through the ages, received so much fruitful inspiration. Now you will realize what a shock I got when, after my address, a member of the audience came up to me and said that he could not understand why I hated the Swedes. Obviously I must have expressed myself most confusingly on that occasion, and I am afraid that also to-day I have talked in a very obscure way. Still, I hope that I have not spoken so obscurely as to give rise to any such misunderstandings of the trend of my argument.

Modern Trends in Air Transport*

MOST modern air transport is by means of the aeroplane, a body heavier than air, depending upon forward movement for sustentation. For purposes of this examination it can be considered to consist of four fundamentally different systems: (1) the lifting system, that is, the wings; (2) the non-lifting system, principally the body, a structure with space for the load, a girder carrying the tail control units, and often the power plant; (3) the propulsive system comprising the engines and airscrews; (4) the control system, including all devices by which the pilot governs the movements of his aircraft. The trend in development of each of these is examined from the point of view of its approach towards air transport ideals of carrying capacity, speed, range, economy, comfort and safety.

The lift of a wing increases with its area, the square of the speed, and, in general, its angle of attack. Increase of lift therefore demands some combination of larger values of these. It must be remembered that carrying capacity is not gross lift; but rather the surplus of the total lift over that necessary to sustain the weight of the structure, engines, etc. Assuming wing structures carrying the same load per unit area, with the same geometry of structure and materials of construction, while the lift will increase as the square of the dimensions, the volume, and consequently the weight, of the wing will increase as the cube of these. This relationship, known as the square/cube law, implies that with weight increasing at a greater rate than lift, the carrying capacity of any wing system will ultimately be reduced to zero. The functioning of this law is being defeated by designers by the more efficient distribution of the materials in the structure, the use of specifically stronger (strength/weight) materials, and improved aerodynamic design allowing increased speed for the same power, and consequently extra lift from the same wing area. This is further helped by the fact that the power required is a factor of the wing area, and its weight is only increasing as the square of the linear dimensions of the machine. Increase in angle of attack, as a method of obtaining additional lift, results in an increase in drag of the wing at such a rate that the weight of the extra power plant necessary to overcome it soon cancels out its extra lift. As an example, early post-War commercial aeroplanes weighed from three to five thousand pounds with a wing loading of eight to twelve pounds per square foot, and there was evidence that the optimum size under the square/cube law was already approaching. A new Boeing flying boat, now building, will weigh 82,000 lb. with a carrying capacity of 10,000 lb., while some projected designs for trans-ocean services are of 200,000 lb. total weight and expect to carry a pay load of 25,000 lb., with wing loadings of 30–40 lb. per square foot.

The question of speeds is one of commercial requirements. They have risen from 50–80 miles per hour to 150–200 miles per hour normal cruising

* Based on a lecture by Prof. W. F. Durand, emeritus professor of mechanical engineering in Stanford University, given at the recent meeting of the American Association for the Advancement of Science, Richmond, Virginia.

speeds, with much higher top speeds when necessary. The probable highest possible speed of flight that can be visualized at present is about 500 miles per hour, assuming a machine with its various characteristics combined in an optimum manner for this alone, a quite impractical proposition in many other respects. Excluding commercial stratosphere flight—as yet unproved—300 miles per hour appears to be about the practicable limit for commercial aircraft.

Range, the distance flown without alighting or refuelling, obviously depends upon an arbitrary balance between paying load and fuel carried. The theoretically maximum range, with no pay load, and neglecting the effect of weather conditions, assuming a machine designed specially for maximum performance in this respect, appears to be of the order of 8,000–9,000 miles. The present record is about 7,000 miles, and it is not unfair to say that the reduction in this figure is largely due to adverse weather conditions and the limitations of the human element in the control of the machine. Economic considerations bring this figure down considerably; the China Clipper flying boats on the Pacific service, making flights necessarily 2,000 miles in length, are not considered to be a paying proposition to-day. It is anticipated that the new 82,500-lb. flying boat, already mentioned, will have an economic range of 2,400 miles at a cruising speed of 150 miles per hour. It is interesting to note that the cost of operating these long-range commercial flights is curiously stable at an average of 2 cents per passenger seat per mile.

These performances may also be modified by taking advantage of the reduced resistance of the more rarefied air at high altitudes. Here again record flights on special machines (52,937 ft.) have no commercial significance; but it appears that more economical flight should be possible in the sub-stratosphere between the altitudes of 20,000 ft. and 30,000 ft. Experimental flights at between 15,000 ft. and 20,000 ft. are already being arranged. The two essentials, that of supplying the engine with the necessary oxygen by supercharging it, and providing the air conditions required for the passengers' comfort by enclosing them in a pressure-tight cabin, have already been accomplished. A Boeing No. 307 is being built for sub-stratosphere flight, with a range of 1,000 miles at 180 miles per hour, carrying a pay load of 9,200 lb.

Comfort for passengers is also an economic question, being principally one of the extra size of the body, with its additional drag and weight, the weight of furnishings of the cabin, the number of crew carried, provision of meals en route and more solid walls for sound- and weather-proofing. All of these are being met in a spirit of competition nowadays.

Safety, principally a matter of allowing for certain adverse weather conditions, can best be studied by considering those conditions in groups that affect an aeroplane differently. Structural breakages due to bad design are practically unknown, and failures of the power plant are being rapidly reduced to a negligible quantity. The Diesel type of engine with its simpler carburation, ignition, and less inflammable fuel, is the more attractive from this point of view, although its performance is inferior in some respects. Flying and navigational instruments are available for all needs, including blind flying and landing in fog, although the human element has to be considered in the limitation of the number of operations that any one person can carry out at the same time. Among more recent developments in this respect are an 'echo' altimeter giving the height of the machine above the ground in the immediate vicinity, a static suppressor that eliminates interference in radio communication, and an automatic radio direction finder working with a gyro-pilot. 'Stall' warning devices of various kinds, coupled with aerodynamic improvements in the control of a machine when flying slowly, have done much to reduce the hazards of taking-off and landing.

The autogyro—a rotating-wing aeroplane—and the helicopter—a flying propeller—are two developments that may have special applications because of some peculiarity that they possess; but their inferior performance in competition with the more conventional aeroplane would appear to limit their use for general air transport.

The position with regard to lighter-than-air craft is not so clear at the present time. Experience dictates that some inert gas, of which helium appears to be the only practicable one, must be used, for reducing fire danger. The restricted supply of this, limited to certain parts of the world, is likely to be a serious factor in the development of airships.

Structural failures in airships of the past have been serious, but lessons have been learned from their investigation, and it is claimed that airships could be built to-day with a structural margin of safety at least equal to a modern aeroplane. Airships are also immune from two possible dangers present in heavier-than-air craft: forced landing due to engine failure, and loss of control resulting in a spinning dive.

In conclusion, it is claimed that although practical flight, which came into being with the success of the Wright brothers in 1903, has presented the transport world with new problems by reason of the fact that it functions in an additional third dimension, they have not proved impossible of solution in both the technical and economic point of view.

Pope Pius XI and His Scientific Interests

WITH the lamented death of His Holiness Pope Pius XI on Friday, February 10, the Christian world at large, and the Catholic body in particular, have lost a spiritual leader who will go down in history as a saintly man of courage and character, of kindliness and tolerance, of piety and science.

The duties and interests of a Roman Pontiff are manifold in character. As religious head of the Church, he has to keep, to interpret and to defend the doctrinal and moral teachings of Catholicism. The task of the late Pope in this respect was a difficult one, in view of the social theories and practices of certain totalitarian States. Pius XI placed the whole weight of his authority against individual, social and racial persecution.

As temporal sovereign, the Pope has to consider the political and administrative duties of his exalted position. But in spite of the heavy burden these duties involved, Pius XI never failed to show an active interest in science and its advancement; as a student, he was soon to realize the importance of science not only in a world which is obviously actuated by it, but also for the final shaping of one's philosophical and religious knowledge. As a young scholar, as a curator of the Ambrosian, and afterwards of the Vatican Libraries, as a prelate and finally as a Pope, Pius XI was always assisting the peaceful development of the positive sciences in their various fields of application. For he was convinced that there could be no real incompatibility between science and faith.

The Lateran Treaties, which sealed the peace between the Vatican and the Italian State in 1929, gave the Pope the opportunity of showing in a conclusive manner that he was not only the Pope of peace, but also the Pope of scientific progress. Pius XI took a personal interest in the planning, building and reconstruction of the scientific institutions of his miniature but model State. In November 1930 was opened the new central telephone exchange of the Vatican City; in the following February, the new electric power station and the new wireless station were inaugurated.

The Pontiff was particularly proud of the powerful wireless station at Castelgondolfo, his summer residence, in which the late Senator Marconi embodied the latest devices. The experiments, the tests and the first messages transmitted from Castelgondolfo in April 1932, were followed with the greatest interest by the scientific world. In fact, special receiving apparatus had to be supplied to authorities abroad to suit the requirements of the ultra-short wave station of Castelgondolfo. Catholics in all parts of the world were thus able to hear in their homes the voice of the Pope himself.

The head of the Church was always ready to co-operate with international scientific organizations. A notable event was the official participation of Vatican delegates to the International Congress of Aeronautics in September 1931 at Budapest. The Pope himself was always ready when his other duties allowed him the time to do so, to receive representatives of learned or technical congresses held in Rome.

The work of the Pontifical institutions in Rome proper was followed with active interest by Pius XI. The inauguration of the new buildings of the Gregorian University in November 1930, of the College of the Propagation of Faith in April 1931, of the Art Gallery in October 1932, the collapse of the roof of the Vatican Library and its subsequent reconstruction, and other similar events, gave the Pope many occasions to confirm his support for the achievements of science. The Pope was informed also of the scientific results obtained by the scholars personally in the Pontifical institutions, not only in Rome, but also in the Catholic University of Milan, which has a world-famous school of experimental psychology under Father Gemelli, and in similar institutions abroad.

The crowning example of the Pope's interest in pure science was the reconstitution in 1936 of the Pontifical Academy of Sciences, which is now housed in the Casina Pio IV in the Vatican gardens, through the generosity of Pius XI himself. The Academy, which was known in the past as the Pontificia Accademia dei Nuovi Lincei, now consists of seventy members chosen from among the most distinguished men of science, irrespective of nationality and of religious profession. The British members are Sir Charles Sherrington and Prof. E. T. Whittaker; the late Lord Rutherford was also a member. His Holiness was present himself at the opening of the new Academy in June 1937.

At the inaugural meeting of the Pontifical Academy last year, Pope Pius XI paid a personal tribute to the benefits conferred on mankind by the labours of Marconi, whom he honoured with his friendship, and of Hertz, to whose widow now living in exile at Cambridge His Holiness made a personal gift of £250. Their work, said the Pope, was accompanied by Divine blessing and recalled the words of Schiller: "Soll das Werk den Meister loben, doch der Segen kommt von oben."

T. GREENWOOD.

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SUPPLEMENT

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LETTERS TO THE EDITOR

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 290.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

PHYSICAL SCIENCES

Radioactivity of Sea Water

THERE still exists considerable uncertainty regarding the amount of radioactive elements present in sea water, the values found by different investigators varying between very wide limits. In general, a few units of 10^{-12} gm. radium per litre is considered a fair average, although occasionally much higher values have been reported. As regards thorium, the estimates are still more uncertain, generally upper limits only of the content being given, whereas with uranium no sufficiently sensitive method for measuring this element existed until quite recently[1].

Since 1934, through collaboration between this Institute, the Institut für Radiumforschung in Vienna and the Kjemisk Institutt in Oslo, we have tried to develop accurate methods for measuring the content of the three elements mentioned in sea water.

Uranium has been measured (by its fluorescence in beads of sodium fluoride excited with ultra-violet radiation) in a considerable number of water samples, taken in coastal as well as in mid-ocean waters and at various depths down to several thousand metres. The results show that uranium is a constant component of sea water, varying in proportion with the total salinity. Ocean water of 35 per thousand salinity holds about 2×10^{-6} gm. uranium per litre, or 2×10^{-9} gm. uranium per gm.

Radium measurements have proved much more difficult, since the amount present is only a small fraction of the anticipated value mentioned above. Success was first achieved in 1936, when we started using a *Mitreissreaktion*, precipitating the radium as sulphate together with barium sulphate by adding small quantities of chloride of barium, of a low and accurately measured radium content, to large quantities of sea water. Working on volumes of 25–200 litres of water from the Baltic, the Kattegat, the Skagerak and the fjords of Bohuslän, taken at depths from the surface down to 600 metres, we found the radium content to vary between 0·03 and $0{\cdot}2 \times 10^{-12}$ gm. radium per litre. We are not yet able to state with certainty to what extent these variations are due to differences in the radium content with locality, depth, salinity and time.

Separate measurements on the radium concentrated in plankton cells, diatoms extracted from about 6,000 cubic metres of surface water during the spring increase, appear to negative the assumption that particulate matter suspended in the water may be responsible for sensible variations in its radium content.

The average value found from these measurements, namely, $0{\cdot}07 \times 10^{-12}$ gm. radium per litre, receives further support from measurements on the radium contained in mollusc shells, *Mytilus edulis* and *Ostrea edulis*. The radium-calcium ratio was found to be about $0{\cdot}2 \times 10^{-12}$, which corresponds to a radium content in the water of rather less than $0{\cdot}1 \times 10^{-12}$ gm. radium per litre. It seems significant that this radium content is only about one tenth of the equilibrium amount corresponding to the uranium content already stated. It has been suggested by one of us[2] that this apparent deficiency of radium in the sea may be due to a more or less complete removal from sea water of ionium, the parent element of radium and an isotope of thorium, caused by the large-scale precipitation of iron as ferric hydroxide occurring in the sea, especially in coastal waters.

The very low radium content, say less than 10^{-16} gm. radium per gm. water, shows that sea water is several hundred times poorer in radium even than meteoritic iron. If the high radium content in certain samples of red clay and radiolarian ooze were really due to a precipitation of radioactive elements from the superposed column of water, it would appear more likely to assume ionium to be precipitated with iron than either uranium or radium itself. The implications following from this possibility will be tested by us in the near future.

Also, in our thorium measurements we have found it necessary to use a precipitation method, adding ammonia and ferric chloride (purified from thorium)

to large quantities of sea water, to which ammonium chloride had been added beforehand. The thorium content was found to be certainly less than 10^{-6} gm. thorium per litre and probably less than half that amount. If we assume the removal of thorium from sea water through natural precipitation with iron to be as efficient as the removal of ionium, taking the thorium-uranium ratio in the denuded rocks to be 2 : 1, we should expect the thorium content in sea water (judging from its uranium content) to be reduced from, say, 4×10^{-6} gm. thorium per litre to one tenth that amount, that is, to 4×10^{-7} gm. thorium per litre, or very probably still further.

A detailed report on our measurements will appear in *Meddelanden från Oceanografiska Institutet i Göteborg*.

Since writing this account of our work, our attention has been directed to a paper by R. D. Evans, Arthur F. Kip and E. G. Moberg[3]; working by different methods and using much smaller quantities of sea water, these investigators have found values for the radium content not much different from those we have found with water of quite different origin.

Ernst Föyn.
Bornö Station, Berta Karlik.
Sweden. Hans Pettersson.
Elisabeth Rona.

[1] *Medd. Ocean. Inst.*, No. 11 (1937).
[2] *Wiener Akad. d. Wissenschaften*, July 1, 1937.
[3] *Amer. J. Science*, Oct. 1938.

Physical Evidence for the Division of Heavy Nuclei under Neutron Bombardment

From chemical evidence, Hahn and Strassmann[1] conclude that radioactive barium nuclei (atomic number $Z = 56$) are produced when uranium ($Z = 92$) is bombarded by neutrons. It has been pointed out[2] that this might be explained as a result of a 'fission' of the uranium nucleus, similar to the division of a droplet into two. The energy liberated in such processes was estimated to be about 200 Mev., both from mass defect considerations and from the repulsion of the two nuclei resulting from the 'fission' process.

If this picture is correct, one would expect fast-moving nuclei, of atomic number about 40–50 and atomic weight 100–150, and up to 100 Mev. energy, to emerge from a layer of uranium bombarded with neutrons. In spite of their high energy, these nuclei should have a range, in air, of a few millimetres only, on account of their high effective charge (estimated to be about 20), which implies very dense ionization. Each such particle should produce a total of about three million ion pairs.

By means of a uranium-lined ionization chamber, connected to a linear amplifier, I have succeeded in demonstrating the occurrence of such bursts of ionization. The amplifier was connected to a thyratron which was biased so as to count only pulses corresponding to at least 5×10^5 ion pairs. About fifteen particles a minute were recorded when 300 mgm. of radium, mixed with beryllium, was placed one centimetre from the uranium lining. No pulses at all were recorded during repeated check runs of several hours total duration when either the neutron source or the uranium lining was removed. With the neutron source at a distance of four centimetres from the uranium lining, surrounding the source with paraffin wax enhanced the effect by a factor of two.

It was checked that the number of pulses depended linearly on the strength of the neutron source; this was done in order to exclude the possibility that the pulses are produced by accidental summation of smaller pulses. When the amplifier was connected to an oscillograph, the large pulses could be seen very distinctly on the background of much smaller pulses due to the alpha particles of the uranium.

By varying the bias of the thyratron, the maximum size of pulses was found to correspond to at least two million ion pairs, or an energy loss of 70 Mev. of the particle within the chamber. Since the longest path of a particle in the chamber was three centimetres and the chamber was filled with hydrogen at atmospheric pressure, the particles must ionize so heavily, in spite of their energy of at least 70 Mev., that they can make two million ion pairs on a path equivalent to 0·8 cm. of air or less. From this it can be estimated that the ionizing particles must have an atomic weight of at least about seventy, assuming a reasonable connexion between atomic weight and effective charge. This seems to be conclusive physical evidence for the breaking up of uranium nuclei into parts of comparable size, as indicated by the experiments of Hahn and Strassmann.

Experiments with thorium instead of uranium gave quite similar results, except that surrounding the neutron source with paraffin did not enhance, but slightly diminished, the effect. This gives evidence in favour of the suggestion[2] that also in the case of thorium, some, if not all, of the activities produced by neutron bombardment[3] should be ascribed to light elements. It should be remembered that no enhancement by paraffin has been found for the activities produced in thorium[3] (except for one which is isotopic with thorium and is almost certainly produced by simple capture of the neutron).

Prof. Meitner has suggested another interesting experiment. If a metal plate is placed close to a uranium layer bombarded with neutrons, one would expect an active deposit of the light atoms emitted in the 'fission' of the uranium to form on the plate. We hope to carry out such experiments, using the powerful source of neutrons which our high-tension apparatus will soon be able to provide.

O. R. Frisch.
Institute of Theoretical Physics,
University,
Copenhagen.
Jan. 16.

[1] Hahn, O., and Strassmann, F., *Naturwiss.*, **27**, 11 (1939).
[2] Meitner, L., and Frisch, O. R., NATURE [**143**, 239 (1939)].
[3] See Meitner, L., Strassmann, F., and Hahn, O., *Z. Phys.*, **109**, 538 (1938).

The Fundamental Length Introduced by the Theory of the Mesotron (Meson)*

It is well known that the vector theory of the meson[1] contains a fundamental length in the interaction of mesons with protons and neutrons determined by the fact that the mass of the meson appears

* The name 'mesotron' has been suggested by Anderson and Neddermeyer (NATURE, 142, 874; 1938) for the new particle found in cosmic radiation with a mass intermediate between that of the electron and proton. It is felt that the 'tr' in this word is redundant, since it does not belong to the Greek root 'meso' for middle; the 'tr' in neutron and electron belong, of course, to the roots "neutr" and "electr". In these circumstances, it seems better to follow the suggestion of Bohr and to use electron to denote particles of electronic mass independently of their charge, and negaton and positon to differentiate between the sign of the charge. It would therefore be more logical and also shorter to call the new particle a meson instead of a mesotron.

explicitly in the denominator of some of the interaction terms. This circumstance has the result that in those elementary processes in which the momentum change is large compared with mc, m being the mass of the meson, the interaction becomes very large, leading to Heisenberg explosions, and to greater divergences in some second-order effects than is the case in radiation theory. This has led Heitler[2] and others to the view that the meson theory in its present form is quite incorrect for meson energies larger than about mc^2, and Heisenberg[3] to the position that quantum mechanics is competent to deal accurately with only those elementary processes in which the condition[4] due to Wataghin,

$$\left|\left(\frac{E_1-E_2}{c}\right)^2-(p_1-p_2)^2\right| \ll \left(\frac{\hbar}{r_0}\right)^2, \qquad (1)$$

is satisfied, E and p being the initial and final energy and momenta of a particle concerned in the process, and r_0 a fundamental length of the order $\hbar/mc$. The purpose of this note is to bring forward an argument which, it seems to me, shows first that the limitation of quantum mechanics by the condition (1), if true, cannot be based on the explosions as derivable from the theory of the meson, and secondly, to throw some doubt on (1) itself as a limit to the correctness of quantum mechanics.

The argument runs as follows. Let us consider uncharged mesons[5] for simplicity, since this changes nothing essential to the argument, and consider the Hamiltonian given in A (49)[1]. The interaction (58 a) in this contains terms which become very large when the momentum change of the meson becomes large compared to mc in a suitable Lorenz frame. These terms, which lead to explosions, are due *as much to the transverse meson waves as to the longitudinal ones*, even in the limit when the proton may be considered to be moving non-relativistically. Further, the critical momentum above which explosions begin to appear becomes lower the smaller mc, and becomes vanishingly small when $mc \to 0$.

On the other hand, *the exact quantized equations of motion for the meson field derivable from this Hamiltonian* (A (14) and (15), with the appropriate simplifications for a neutral meson), namely,

$$G_{\mu\nu} = -\left(\frac{\partial}{\partial x^\mu}U_\nu - \frac{\partial}{\partial x^\nu}U_\mu\right) + \frac{g_2}{\hbar c}\,\psi^+\gamma^\mu\gamma^\nu\tau_3\psi$$

$$\frac{\partial}{\partial x_\mu}b_{\mu\nu} = \frac{m^2c^2}{\hbar^2}U_\nu + \frac{g_1}{\hbar c}\,\psi^+\gamma^\nu\tau_3\psi$$

go over continuously into the Maxwell equations when $m \to 0$. But one knows from electrodynamics that although there are circumstances in which the emission of a large number of quanta may be more probable than the emission of a single quantum, as in the so-called 'infra-red catastrophe', this in no way sets a limit to the accuracy of quantum mechanics *and does not interfere with the calculation of less probable processes by the methods of perturbation theory*. Moreover, it is just those processes where the emission of a large number of quanta is very probable which can be calculated classically.

In view of the above circumstances, we must conclude that the appearance of the fundamental length determined by the mass of the meson in the interaction term in no way sets a limit to the accuracy of quantum mechanics. For example, in the collision of two protons with energy very large compared to mc^2, the probability becomes large for the simultaneous emission of a large number of mesons, which is the analogue of the 'infra-red catastrophe' for quanta of finite rest mass, and hence quantum mechanics is none the less competent to deal with it. It can similarly be shown that *we can calculate the production of large explosions to a high degree of accuracy by treating the meson field quantities classically*, that is, as non-quantized magnitudes, for since mesons satisfy Einstein-Bose statistics, the meson field becomes a classical one just in the case where we are dealing with a large number of mesons.

Hence if a fundamental length r_0 exists which limits the applicability of present quantum mechanics to the cases satisfying (1), this length r_0 has nothing to do with the mass of the meson or the appearance of explosions. Quantum mechanics in its present form cannot be strictly valid since it leads to divergent results connected with the self-energies of point charges; but these limitations are probably due to the fact that it is not the quantization of the correct classical equations for point charges, and not to the existence of a fundamental length r_0. These equations have only recently been given by Dirac[6] and their quantization has not yet appeared.

Accordingly, we might expect that very fast protons (or neutrons) would produce explosions consisting of mesons of momenta roughly mc, while mesons with energy much larger than the proton rest-energy would *not* do so, and their scattering by protons would also decrease with increasing energy, in analogy with the Compton effect.

It can be shown that the classical retarded meson field and potentials due to the world line of a classically moving proton or neutron can be written as the sum of two parts. The first part has exactly the form that the corresponding electromagnetic quantities would have for a point charge and point dipole (represented by a six-vector) moving along a classical world line, and does not contain the mass of the meson. The second part has no singularity at any point of space including the world line of the proton, and goes to zero as the mass of the meson $m \to 0$. The meson singularities are therefore *identical* with the electromagnetic singularities, and it is possible to eliminate these to the same degree and in the same way as has been done by Dirac[6] for the electromagnetic field of a point charge.

The detailed calculations will be published elsewhere.

H. J. BHABHA.

Gonville and Caius College,
Cambridge.
Dec. 17.

[1] Kemmer, NATURE, **141**, 116 (1938); *Proc. Roy. Soc.*, A, **166**, 127 (1938). Fröhlich, Heitler and Kemmer, *Proc. Roy. Soc.*, A, **166**, 154 (1938). Bhabha, NATURE, **141**, 117 (1938); *Proc. Roy. Soc.*, A, **166**, 501 (1938), referred to above as A; Yukawa, Sakata, and Taketani, *Proc. Phys. Math. Soc. Japan*, **20**, 319 (1938). Stueckelberg, *Helv. phys. Acta*, **11**, 299 (1938).
[2] Heitler, *Proc. Roy. Soc.*, A, **165** (1938).
[3] Heisenberg, *Z. Phys.*, **110**, 251 (1938).
[4] Wataghin, *Z. Phys.*, **66**, 650 (1931); **73**, 126 (1931).
[5] Kemmer, *Proc. Camb. Phil. Soc.*, **34**, 354 (1938).
[6] Dirac, *Proc. Roy. Soc.*, A, **167**, 148 (1938). See also Pryce, *Proc. Roy. Soc.*, A, **168**, 389 (1938).

Magnetism and the Maxwellian Theory

I AM glad to see from Mr. Rollo Appleyard's letter in NATURE of December 31 that he is satisfied with my reply to his query concerning the place of magnetism in fundamental electrical theory. Of course there can be no question of "annihilating magnetic notions" in view of the existence and properties of

permanent magnets; but, as regards the understanding of fundamental physical phenomena, magnetism appears to have played a part similar to that of money in economics—a useful link for facilitating exchange, but a source of unnecessary complexity and confusion in discussion. Since we can formulate the forces acting on moving electric charges directly from Ampère's experiments without introducing magnetism, and thereby dispense with the two stages of reasoning involved in Maxwell's curl equations, it seems decidedly advantageous to do so; and if a magnetic field is merely a translationally moving electric field, as the flux-cutting principle suggests, it seems superfluous to regard it as a separate entity.

What we have hitherto called an electromagnetic wave is simply a wave of electric force and displacement, or electric wave, corresponding to the pressure and displacement in an acoustic wave; and the dualistic concept of two waves of electric and magnetic force in perpendicular planes is a superfluous complication. The electrostatic forces between stationary charged bodies and the propagation of electric waves can be illustrated satisfactorily by assuming protons and electrons to be connected by contractile tentacles or bonds, and the only phenomenon which seems unexplainable by mechanical principles is the transverse force on a moving charge caused by the proximity of another moving charge. This is perhaps the most important fundamental problem in physics and may seem to justify the vortical concept of a magnetic field; but this concept does not appear to provide a convincing explanation. We do know, however, from Ampère's experiments, what this force is; and the general formula given in my letter in NATURE of December 3 enables us clearly to understand the behaviour even of dynamos and transformers without any consideration of magnetism.

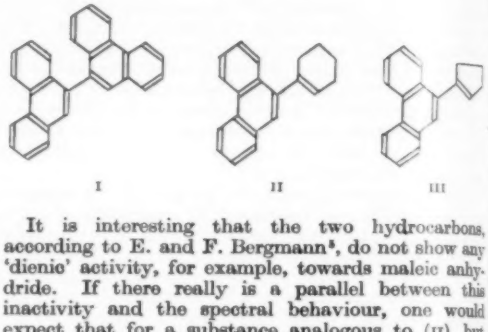
Mr. Appleyard has, however, raised another important fundamental point by directing attention to the fact that this force as given by the second term in my equation: $E_2 = \frac{e}{c^2 r^2}[V'[V\rho]]$, has no meaning unless the velocities V and V' are defined with respect to a basic framework or medium. This term is in accordance with Maxwell's treatment of moving charged surfaces ("Treatise", 2, xix, § 769); with Ampère's experiments; and with the flux-cutting equations given in my article in NATURE of February 5, 1938. These equations: $H' = [VJ] = \varkappa[VE]$, and $E' = -[VB] = -\mu[VH]$, appear to be the true fundamental equations if the magnetic link is employed, and lead to the relation $E' = \varkappa\mu V^2 E$ for an isotropic dielectric medium if that link is eliminated; but it is evident that they also have no meaning for space unless V is defined relatively to a basic framework or medium; and the physical picture of electric wave propagation which arises from them is so clear and convincing as to leave no room for doubt that electric waves, including light, are undulatory electric displacements in a basic medium or ether which has the properties of a dielectric. I believe that this will be acknowledged in due course, and that the classic theories and concepts of Newton, Faraday and Maxwell will be restored to their rightful eminence.

C. V. DRYSDALE.

The Athenæum.
Jan. 5.

Ultra-violet Absorption Spectrum and Chemical Reactivity of some Substituted 9-Vinyl-Phenanthrenes

THE direct conjugation between two aromatic nuclei or between an aromatic nucleus and an olefinic double bond expresses itself in the spectrum: diffuse bands appear instead of the sharp ones and at higher wave-lengths (diphenyl[1], di-α-naphthyl[2], styrene[3], etc.). It is therefore worth reporting that 9,9'-diphenanthryl (I), although having a system of two conjugated olefinic double bonds, exhibits a spectrum which is practically identical with that of phenanthrene[4] (two regions of absorption: persistent, diffuse bands between 2700 and 3000 A., and sharp bands at higher concentrations, between 3000 and 3500 A.). The same is true for 9-cyclohexenyl-phenanthrene (II), which does not behave spectroscopically analogously to styrene.



I II III

It is interesting that the two hydrocarbons, according to E. and F. Bergmann[5], do not show any 'dienic' activity, for example, towards maleic anhydride. If there really is a parallel between this inactivity and the spectral behaviour, one would expect that for a substance analogous to (II), but having an active conjugation, the spectrum should show the above-quoted characteristic features. This is actually the case: 9-cyclopentenyl-phenanthrene (III), which easily combines with maleic anhydride, has fewer and markedly more diffuse bands than phenanthrene, at the same time shifted towards the visible part of the spectrum.

A detailed description of our results and a report on other cases of such an unusual coincidence will be given elsewhere.

VICTOR HENRI.

Institute of Physical Chemistry,
University, Liège.

ERNST BERGMANN.

Daniel Sieff Research Institute,
Rehovoth, Palestine.
Dec. 25.

[1] Pestemer and Mayer-Pitsch, *Monatshefte*, **70**, 104 (1937). Titeica, *C.R. Acad. Sci.*, **199**, 458 (1934).
[2] Pestemer and Cecelsky, *Monatshefte*, **59**, 113 (1932). Brass and Patzelt, *Ber. deutsch. Chem. Ges.*, **70**, 1349 (1937).
[3] Ley and v. Engelhardt, *Z. phys. Chem.*, **74**, 31 (1910). Ley and Dirking, *Ber. deutsch. Chem. Ges.*, **67**, 1331 (1934). Pestemer and Willigert, *Monatshefte*, **66**, 119 (1935).
[4] Mayneord and Roe, *Proc. Roy. Soc.*, A, **152**, 299 (1935). Godart, *Bull. Roy. Soc. des Sciences Liège*, No. 3-4 (1938).
[5] Bergmann, E., and Bergmann, F., *J. Amer. Chem. Soc.*, 59, 1437 (1937).

Atomic Lines in the Auroral Spectrum

PROF. L. VEGARD'S recent note[1] on the atomic lines in the auroral spectrum calls for some comments. While it is true that the presence of the Vegard-Kaplan bands in auroral spectra was first observed and interpreted by Vegard, R. Bernard reported an auroral spectrum in which these bands

and the 3,470 line were unusually strong in comparison with the rest of the spectrum. The remarkable resemblance between this auroral spectrum and the high-pressure afterglow spectrum discovered by me led Bernard to interpret the radiation at 3,470 as a line rather than as the 2 *P.G.* (3–4) band as proposed by Vegard. One must give Bernard credit for an important new observation in recognizing this resemblance.

It must be pointed out that Vegard's interpretation of this 3,470 radiation as a nitrogen band is very difficult to understand. As support for this interpretation, Vegard cites the fact that other bands of the progression 2 *P.G.* (3–*n*) appear in the auroral spectrum. These other bands should be much more intense, however, than the band 3469 (3–4), whereas in Vegard's own auroral spectra the 3469 band is the most intense of the three bands 3285 (3–3), 3671 (3–5) and the 3469 band. An examination of any laboratory source of this system will show immediately that this discrepancy will rule out Vegard's explanation and lends support to that proposed by Bernard. Furthermore, the band at 3469 is stronger than the 3500 band in the same sequence. In the large number of afterglow and discharge spectra that have been photographed by me during the last decade, I have never observed such a large enhancement in the intensity of this band as that implied by Vegard. It appears, therefore, that the greater part of the radiation at 3470 is due to the ^2P—$4S$ line, and only a very small fraction to the 3–4 band.

I have also obtained some new spectra which should further help to settle this question. Several years ago[2] I produced the green auroral line in rapidly interrupted weak discharges with remarkably large relative intensity. Accompanying this weak discharge was an afterglow showing an equally remarkable enhancement of the Vegard-Kaplan bands. It was recently possible to duplicate this phenomenon in the high-pressure afterglow. In this case the new nitrogen line (instead of the auroral green line) is so strong that it is at least ten times as intense as the strongest second-positive band. This new experiment leaves no question in my mind as to whether the radiation around 3470 is a band or a new line, and it also adds heavily to the evidence which favours both Bernard's identification as well as my proposal that the line is the transition ^2P—$4S$ in atomic nitrogen.

JOSEPH KAPLAN.
Departments of Physics and Astronomy,
University of California at Los Angeles.

[1] Vegard, L., NATURE, **142**, 670 (1938).
[2] Kaplan, J., *Pub. Astr. Soc. Pac.*, **47**, 257 (1935).

Photo-sensitive Titanium Dioxide

ATTENTION has already been directed to the reversible darkening in daylight exhibited by some varieties of commercial titanium dioxide[1]. Mechanisms for this darkening were suggested and the possibility that the phenomenon is connected with iron present as an impurity in the titania was borne in mind. Titanium dioxide contaminated by iron, which shows rapid reversible darkening in daylight, has been prepared by the following simple process.

Titanium dioxide is mixed with an aqueous solution containing enough iron salts to add 0·2 parts by weight of Fe_2O_3 to 100 parts by weight of TiO_2. The mixture is evaporated to dryness. The residue is ground for a few minutes and then calcined for three hours to a final temperature of 1,000° C. Calcination is performed in a metallic resistance furnace wherein the titania is freely exposed to air. The resulting readily pulverizable product when ground is ready for study.

The titanium dioxide used in the experiments showed no perceptible darkening in daylight and gave the following spectrographic analysis (prepared by Messrs. Adam Hilger, Ltd.). Ca, trace; Fe, very slight trace; Na, very slight trace, practically 0; P, trace; Pb, minute trace, practically 0; Sb, slight trace; Si, heavy trace; Sn, minute trace. Elements sought with negative result: Ag, Al, As, B, Ba (probably; lines masked), Be, Bi, Cd, Co, Cr, Cu, K, Li, Mg, Mn, Mo, Ni, Sr, Th, Tl, V, W, Zn, Zr.

Iron was added to this oxide as ferrous sulphate or ferric ammonium sulphate, both of analytical reagent quality.

Very precise standardization of quantities or heating schedules is not necessary to obtain striking results. Moreover, there is evidence that certain metals other than iron, used as contaminators, give rise to photo-sensitive preparations.

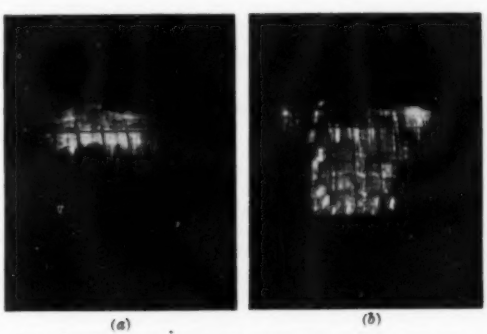
It is hoped to give a fuller account of the subject of this communication, and of related matters, at a later date in the *Transactions of the British Ceramic Society*.

W. O. WILLIAMSON.
Department of Pottery,
North Staffordshire Technical College,
Stoke-on-Trent.
Jan. 16.

[1] Williamson, W. O., NATURE, **140**, 238 (August 7, 1937).

Migration of Barium on Molybdenum

IN a previous letter[1] we stated that no evidence had been obtained for the surface migration of barium over nickel or tungsten. We have recently published these results[2] in detail, together with the results of the behaviour of thorium on tungsten.



(*a*) (*b*)

(*a*) INITIAL DEPOSIT OF BARIUM OVER PART OF WIRE SURFACE. (*b*) COMPLETE MIGRATION AROUND WIRE AFTER 20 HOURS AT 1010° K.

The electron microscope described for round wires has been used to study the behaviour of barium on molybdenum. It has been found that over the temperature range of approximately 1,000°–1,050° K., barium migrates uniformly over molybdenum. Below 1,000° K. no movement occurs, and above 1,050° K. evaporation of barium takes place very rapidly.

The two reproductions show the beginning and end of a run at 1,010° K., with barium on molybdenum. It will be noted that the appearance of the migrated layer is similar to that which we have already shown for thorium.

M. BENJAMIN.
R. O. JENKINS.

Research Staff of the M-O. Valve Co., Ltd.
G.E.C. Research Laboratories,
Wembley.
Jan. 11.

[1] NATURE, 140, 152 (1937).
[2] *Phil. Mag.*, 26, Dec. 1938.

Structure of Proteins

WE have naturally followed with much interest recent developments in the 'cyclol' hypothesis and the structure of the globular proteins[1]; but among other things we find difficulty in correlating the following two statements, presumably arrived at by applying the same theory to the same facts: (1) "The properties of proteins shown by our experiments seem to be in accord with the view that the protein monolayer is a two-dimensional network held together by strong elastic springs and are not in accord with a structure consisting of polypeptide chains"[2]; (2) "This we interpret to mean that, in the formation of monolayers, some or all of the cyclol bonds are opened, few or none of the peptide links being broken, so that protein monolayers consist of polypeptide chains partially or wholly decyclized. . . . This type of structure explains many of their striking characteristics: for example, viscosity, elasticity, etc."[3]

We ourselves, in view of so much evidence to the contrary, have all along felt that inference (1) was scarcely justified; and in fact we have demonstrated experimentally, by direct measurement and X-ray and optical examination[4], that egg albumin monolayers deposited by the Blodgett-Langmuir technique do indeed consist of polypeptide chains; but since no references are given and no reason for the change of view from statement (1) to statement (2), it would be helpful to be informed more fully.

W. T. ASTBURY.
FLORENCE O. BELL.

Textile Physics Laboratory,
University of Leeds.
Jan. 21.

[1] Wrinch, D. M., NATURE, 137, 411 (1936), *et seq.*; Wrinch, D. M., and Langmuir, I., *J. Amer. Chem. Soc.*, 60, 2274 (1938); Langmuir, I., and Wrinch, D. M., NATURE, 142, 581 (1938); Bragg, W. L., NATURE, 143, 73 (1939); Bernal, J. D., NATURE, 143, 74 (1939); Robertson, J. M., NATURE, 143, 75 (1939).
[2] Langmuir, I., Schaefer, V. J., and Wrinch, D. M., *Science*, 85, 76 (1937).
[3] Langmuir, I., and Wrinch, D. M., NATURE, 143, 49 (1939).
[4] Astbury, W. T., Bell, F. O., Gorter, E., and Van Ormondt, J., NATURE, 142, 33 (1938).

THE facts, which Astbury and Bell ask for, that have led me to believe that the spreading of a globular protein on water involves the breakdown of a cyclol cage molecule into polypeptide chains without open ends, were given by me in detail in a lecture on July 1, 1938, at the Cold Spring Harbor Symposium on Proteins, in the ensuing discussion, and in the discussion of Dr. Wrinch's paper on June 30. Dr. Astbury attended these lectures. The lectures and discussions have been published in the Cold Spring Harbor Symposia on Quantitative Biology, vol. 6.

The reasons for the opinion were based upon studies of the viscosities, mechanical properties and solubilities of protein monolayers and a comparison with results obtained with monolayers of several well-recognized long-chain polymers. The fibrous structure that can be developed by shear or by unilateral compression in monolayers of egg albumin, edestin and urease were described and given as additional evidence of the presence of chains in the monolayers. These facts were obtained and the lecture was delivered long after the publication of the "first statement" which Astbury and Bell object to, but before the publication of the paper by Astbury, Bell, Gorter and Van Ormondt.

IRVING LANGMUIR.

Bluffing by Eclipse Prediction

THE communication by Prof. W. A. Osborne[1] has the effect of opening up the question whether the eclipse of the sun mentioned by Anna Comnena may be included in 'historical eclipses'. It is interesting to be able to state that her record seems to be quite sound. There was a total eclipse visible at Constantinople on February 16, 1086.

Most of us have obtained the small amount of knowledge we have about the Emperor and his daughter from the Waverley novel, "Count Robert of Paris". Scott for some reason chooses to describe the lady as being twenty-seven years of age, but he must have known that really her age was only fourteen years, at the time of the story, when the crusaders passed through Constantinople. He gives us a very delightful picture of the daughter reading a newly written chapter of her book to her father for his advice and approval; but here again he must have been equally well informed of the fact that she wrote the work after the emperor's death, when she had taken up her residence in a convent. Now we can all say that she must have had access to reliable records, which enabled her to state with assurance that "the whole [of the sun's] disk was darkened". Usually when a solar eclipse is mentioned by these early writers, the words used are so vague that it is impossible to say whether the eclipse was central or partial at any given locality. In the circumstances, some words of congratulation seem to be due to Anna Comnena and to the authorities who compiled the records from which she derived her information.

The total phase occurred at Constantinople about 4.12 p.m. local mean time. The track of the shadow from the Ægean to the Black Sea seems to be as follows:

Longitude	Latitude
24° 22′ E.	39° 34′ N
27° 17′ E.	41° 5′ N.
30° 17′ E.	42° 0′ N.
34° 6′ E.	43° 8′ N.

I obtained the date from the catalogue of eclipses in "L'Art de Vérifier les Dates", vol. 1. The calculations are my own.

C. J. WESTLAND.

116 Western Road,
Christchurch, N.1,
New Zealand.
Dec. 30.

[1] NATURE, 142, 837 (1938).

BIOCHEMISTRY

Coupling between Pyruvic Acid Dehydrogenation and Adenylic Acid Phosphorylation

A NEW coupling of oxidoreduction and phosphorylation, with thiamin (vitamin B_1) pyrophosphate as a link of the reaction chain, was found with dry preparations of *Bacterium Delbrückii* (*Acidificans longissimum*). Phosphorylation of added adenylic acid occurs when pyruvic acid is dehydrogenated, and, as reported previously[1], thiamin pyrophosphate is the prosthetic of the enzyme catalysing the dehydrogenation of pyruvic acid.

When a suspension of certain bacterial preparations, containing very little adenylpyrophosphatase, is shaken with air in the presence of pyruvic and adenylic acid, the oxygen consumption is accompanied by disappearance of inorganic phosphate.

Table 1.

	Initial value	0·125 mol. pyruvate —	0·125 mol. pyruvate 0·03 mol. adenylic acid	— 0·03 mol. adenylic acid
Mgm. inorganic P	0·59	0·53	0·31	0·59
Mgm. ('ml') easily hydrolysed P	0	0·06 (42)	0·28 (200)	0·01
− ml O_2	—	490	474	58
$-P:-\frac{1}{2}O_2$	—	0·04	0·21	—

Aerobic experiment: ca. 35 mgm. dried bacteria, suspended in 0·05 mol. sodium fluoride-phosphate solution, were shaken with air at 37·5° for an hour.
Equation: pyruvate (H_2O) + $\frac{1}{2}O_2$ = acetate + CO_2 + H_2O.

The organic phosphate compound formed is split by seven minutes hydrolysis with normal hydrochloric acid (see second line of Table 1). Since tests for phosphopyruvic acid were negative, this is taken as evidence for adenosinpolyphosphate synthesis.

As reported elsewhere[1], dismutation is very poor with the dried bacteria, but can be developed by the addition of riboflavin[2]. The analysis showed dismutation to be a fermentation-like reaction with pyruvic acid–pyruvic dehydrogenase as reductant, pyruvic acid–lactic dehydrogenase as oxidant and flavin acting as hydrogen carrier between the two enzymatic systems. The reductant is the same both in aerobic dehydrogenation and in anaerobic dismutation of pyruvic acid. The oxidants, however, are different, being oxygen in the first case and pyruvic acid-lactic dehydrogenase in the second.

It appears from the anaerobic experiment shown in Table 2 that the dismutative reaction also gives rise to phosphorylation.

Table 2.

	Initial value	0·125 mol. pyruvate 0·03 mol. adenylic acid --	0·125 mol. pyruvate 0·03 mol. adenylic acid 0·1 mgm. riboflavin
Mgm. Inorganic P	0·6	0·59	0·41
Mgm. ('ml') easily hydrolysed P	0	0·01	0·19 (138)
Ml. CO_2	—	5	172
$-P:CO_2$	—	—	0·8

Anaerobic experiment: as aerobic experiment, only with nitrogen.
Equation: pyruvate (H_2O) + pyruvate = acetate + CO_2 + lactate.

Since the coupling takes place anaerobically as well as aerobically, it should be independent of the hydrogen acceptor but intimately associated with the dehydrogenation process catalysed by the mediation of thiamin pyrophosphate. In this connexion, it must be considered that inorganic phosphate is an indispensable component of the pyruvic acid dehydrogenation system[1]. A very close resemblance might exist between the function of the pyridine nucleotide in the coupling reaction in fermentation, analysed by Meyerhof[3] and by Needham[4] in detail, and the function of the thiazole derivative in our reaction[5].

In my opinion, the linkage between the thiamin and adenylic acid systems will prove to be of great importance for the understanding of the metabolic function of thiamin in the living cell. A new source of phosphorylation energy appears which can be utilized both aerobically and possibly anaerobically. The skeletal muscle and to a still greater extent the heart muscle are probably supplied with energy from this source. It is well known that heart failure is one of the most conspicuous symptoms of B_1-avitaminosis[6] and, according to Birch and Mapson[7], the inability of the heart to dispose of free adenylic acid is the cause of the bradycardia of animals deprived of thiamin. Also, the oxidative phosphorylations in kidney and liver, reported by Kalckar[8], might be linked in part to the thiamin system.

I wish to express my sincere thanks to the Ella Sachs Plotz Foundation for the aid given to this work. The adenylic acid was very kindly supplied to me by Dr. P. Ostern.

FRITZ LIPMANN.

Biological Institute,
Carlsberg Foundation,
Copenhagen.
Jan. 7.

[1] Lipmann, *Enzymologia*, **4**, 65 (1937).
[2] Lipmann, Sixteenth Internat. Physiol. Congress, Zurich, 1938, *Ber.*, **2**, 161.
[3] Meyerhof, Ohlmeyer and Möhle, *Biochem. Z.*, **297**, 90 (1938).
[4] Needham and Lu, *Biochem. J.*, **32**, 2040 (1938).
[5] Lipmann and Perlmann, *J. Amer. Chem. Soc.*, **60**, 2575 (1938).
[6] See review by Williams and Spiess, "Vitamin B_1", New York (1938).
[7] Birch and Mapson, NATURE, **138**, 27 (1936).
[8] Kalckar, NATURE, **142**, 871 (1938).

Effect of Nicotinic Acid Deficiency on the Cozymase Content of Tissues

IT is now well recognized, largely through the efforts of the Euler and Warburg laboratories, that nicotinic acid amide is a constituent of both coenzyme I and coenzyme II. Since these coenzymes have such an important role in the metabolic processes of the body, it is of decided importance to acquire more information concerning their physiology. A good deal has been learned from studies with synthetic enzyme systems in which these coenzymes are involved. The *in vivo* approach has been attempted by the Euler group. They have confined themselves to rats as the experimental animals and have encountered many obstacles in their work, since it has been very difficult to demonstrate a clear-cut deficiency in the rat of the coenzymes or of any of their possible precursors. Recently, however, Elvehjem and co-workers[1] have demonstrated a

definite nicotinic acid deficiency in the dog, and Dr. H. Chick *et al.*[2] have made similar observations on the pig. We have thus been enabled to work with two different species in which a definite nicotinic acid deficiency is relatively easy to produce.

Our first approach was an attempt to demonstrate a decrease in the cozymase content of the blood of dogs deficient in nicotinic acid. The cozymase was determined by Euler's method[3], and every analysis was strictly controlled with blood from a normal animal. In no case were we able to find any differences between the cozymase content of the bloods drawn before and after nicotinic acid therapy. Similar results were obtained by analyses on the blood of deficient pigs.

Our next approach was the cozymase analysis of the brain, liver, kidney and muscle of two pigs and one dog, all showing a definite nicotinic acid deficiency. These analyses were also controlled by using for comparison similar tissues from animals fed the basal diet plus nicotinic acid. The following results were obtained:

(*a*) There was no decrease in the cozymase contents of either the brain or kidney.

(*b*) The livers of the deficient animals showed a decrease of about one hundred per cent, while the muscles showed a decrease of so high as one thousand per cent, in their cozymase content.

The accompanying table summarizes the results obtained from the cozymase analyses of normal tissues:

Tissue	Cozymase* (mgm./100 gm. fresh tissue)	Nicotinic acid amide (calc.) (mgm./100 gm. fresh tissue)
Beef muscle	31	5·7
Beef liver	70	12·9
Pig liver	52	9·6

The cozymase values agree with those found by Ochoa[4] for rabbit muscle.

The calculated nicotinic acid amide values are of necessity minimal since the cozymase determination includes neither the free acid or amide, nor coenzyme II. The above values for the amide agree in a general way with the nicotinic acid equivalence obtained by bio-assay on the same tissues[5], and also with those from actual isolation when expected losses are taken into consideration[1,6]. Karrer[7], on the other hand, reports values for nicotinic acid amide which are so low that they cannot begin to account for the cozymase alone which is present in the tissues.

It is evident that the cozymase content of the tissues of normal animals remains quite constant, while in a nicotinic acid deficiency there is a decided decrease in the cozymase content of both the liver and the muscle.

A. E. Axelrod.
C. A. Elvehjem.

Department of Biochemistry,
University of Wisconsin,
Madison, Wisconsin.
Dec. 15.

* We are indebted to Prof. H. von Euler and Dr. F. Schlenk for a sample of pure cozymase and to Mr. H. A. Campbell for weighing the small amount of cozymase used.

[1] Elvehjem, C. A., Madden, R. J., Strong, F. M., and Woolley, D. W., *J. Biol. Chem.*, **123**, 137 (1938).
[2] Chick, H., Macrae, T. H., Martin, A. J. P., and Martin, C. J., *Biochem. J.*, **32**, 10 (1938).
[3] Euler, H., *Ergeb. Physiol.*, **38**, 1 (1936).
[4] Ochoa, S., *Biochem. Z.*, **292**, 68 (1937).
[5] Waisman, H., Mickelsen, O., and Elvehjem, C. A., Unpublished results.
[6] Kuhn, R., and Vetter, H., *Ber.*, **68**, 2374 (1935).
[7] Karrer, P., and Keller, H., *Helv. chim. Acta*, **21**, 1170 (1938).

Inactivation of Progesterone in the Organism

Some years ago, I was able to demonstrate that œstrone which had been administered to the organism very soon became inactive[1]. Mature mice or infantile rats were injected subcutaneously with large doses of œstrone (up to 40,000 M.U.). Three to seventy-two hours after the administration of the hormone the animals were killed, cut into small pieces and extracted *in toto* with an organic solvent. It was apparent that even after a very short time, only very insignificant amounts of the hormone (about 1 per cent) could be detected. There remained, indeed, always a certain quantity of active hormone, sufficient to produce œstrus; but the question whether we were considering a hormone which had not become inactive, or one which had become reactivated again, could not be decided. Œstrone is inactivated in the liver, probably by means of an enzymatic process. This inactivation, apparently, is a general biological reaction, since it takes place not only in warm-blooded, but also in cold-blooded animals and in plants as well.

Similar experiments have now been carried out by means of progesterone. For each experiment (progestine of Organon-Oss was used) two infantile rats were injected subcutaneously with 2·5 mgm. (= 2·5 rabbit units) respectively of progesterone. (An infantile rat tolerates at the most 3·5 mgm. of progesterone.) Forty-eight hours after hormonal treatment the rats were killed, cut into small pieces and ground, including the fur, until a fine mash of tissue resulted. To begin with, this mash was extracted with acetone for some days at room temperature until a fine dry powder was obtained. This was then thoroughly extracted with alcohol and ether for twenty hours in a Soxhlet. All the residue was collected (acetone, ether and alcohol) and only that part which was soluble in absolute alcohol was used. This was dissolved in 10 c.c. of oil (solution *A*) and tested for its content of progesterone (+) in infantile rabbits. For eight days preliminary treatment with 20 M.U. of œstrone respectively was given, after which the rabbits were given daily 2 c.c. of the oily solution *A* during the course of five days. On the fourteenth day the animals were killed and the uterus subjected to histological examination. The presence of the decidual transformation of the uterine mucosa proves that at least 1 rabbit unit (= 1 mgm.) must be present in the extract. The experiments having been set up with 5 mgm., the results furnished proof of the fact that 20 per cent of the progesterone which had been administered is still present in the bodies of the rats.

Administration of progesterone	Time elapsed before extraction (hours)	Progestational transformation is present, that is, 1 mgm. has been detected = 20 per cent
5 mgm.	6	+ + +
5 mgm.	12	+ + +
5 mgm.	24	+ ±
5 mgm.	48	− −
5 mgm.	96	− −

As shown by the accompanying table, the experiments demonstrate: (*a*) that 6 and 12 hours after the administration of progesterone at least 20 per cent of the hormone could be detected in the organism; (*b*) that 24 hours after the administration of the hormone the decidual reaction was inadequate, that is, scarcely 20 per cent was still present; (*c*) that 48 hours after the administration of the hormone the decidual reaction was negative and that there was, therefore, no longer 20 per cent.

Although the progesterone reaction, that is, the decidual transformation of the uterine mucosa, does not occur until about 100 hours have elapsed, even after 48 hours the hormone is no longer present in an active form. In this respect, progesterone is similar qualitatively to œstrone. Inactivation of œstrone, however, occurs much more rapidly and much more intensely than that of progesterone.

Control experiments were set up to prove that, with the help of the extractive method, progesterone which had been added to the mash could again be proved quantitatively.

BERNHARD ZONDEK.

Obstetrical-Gynæcological Department,
Rothschild Hadassah-Hospital,
Jerusalem.
Dec. 8.

Zondek, B., *Lancet*, **227**, 356 (1934); *Scandin. Arch. Physiol.*, **70**, 133 (1934); "Hormone d. Ovariums und d. Hypophysenvorderlappens". Second edition (Vienna: Springer, 1935), pp. 124–147.

Determination of *r*H in Endocrine Extracts of a Protein Nature

WE have begun to study systematically extracts of endocrine glands containing hormones of a protein nature, especially extracts of the anterior pituitary lobe (ALH) of cattle. For technical reasons very dilute extracts were used: 1 gm. of the dry powder, previously kept *in vacuo*, was shaken for 4 hours with 20 ml. of a 0·0001 *N* NH_4Cl solution and then filtered. The *p*H of the filtrate was kept at about 6·2.

Search was made for reducible substances in the solution and their reduction potentials were measured by means of Heyrovsky's polarographic apparatus with the dropping mercury cathode. All measurements were made with a voltage of 3 volts across the potentiometer. Before each experiment a stream of electrolytic hydrogen, thoroughly purified, was bubbled through the solution. The sensitivity used was generally 1/50 and 1/100 of the total sensitivity of the galvanometer.

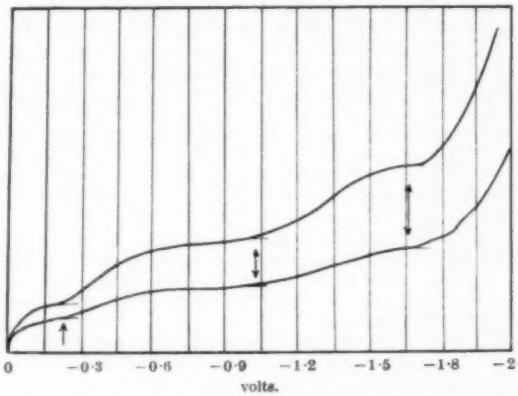
We show first the current voltage curve obtained with an extract of powdered ALH, showing *three steps corresponding with three reducible substances (groups)*, having well-defined reduction potentials: $rH_1 = -0·23$ volts, $rH_2 = -1·00$ volts, $rH_3 = -1·65$ volts. The second decimal figure has no great significance.

These three steps did not appear when the powder had not been kept *in vacuo*; they disappeared gradually as the extract was made more and more alkaline, and completely at *p*H 9·9. These substances (groups) are soluble in ether and in acetone. We were able to repeat these results with powders made from different fresh or frozen glands or glands kept for a time under acetone and also with different extracts prepared from the same gland.

Next, we wished to establish whether the three *r*H values corresponded with different anterior pituitary hormones. We first examined several purified commercial preparations. One of them had, as shown by tests on guinea pigs and rats, a thyreotropic and a gonadotropic action. This preparation, diluted with 0·0001 *N* NH_4Cl, showed reduction potentials at $rH = -0·23$ v. and $rH = -1·65$ v., and therefore corresponds with rH_1 and rH_3 of the total extract of the powdered ALH. Another preparation showed in our own tests a gonadotropic action, but no signs of thyreotropic activity, as determined by the usual guinea pig method. This preparation showed $rH = -0·23$ v. and sometimes $rH = -1·00$ v. and therefore corresponded with rH_1 and rH_2 of the total extract.

Finally, we ourselves prepared extracts from the powdered ALH. One extract showed a gonadotropic action, but no definite thyreotropic effect or only very little. It had a reduction potential of $rH = -0·23$ v. only.

Another extract prepared by us showed some thyreotropic but no gonadotropic action and a reduction potential of $rH = -1·65$ v.; it therefore corresponded with rH_3 of the total extract.



CURRENT VOLTAGE CURVE OF A TOTAL EXTRACT OF POWDERED ALH. ABSCISSA: VOLTAGE, ONE DIVISION = −0·15 VOLTS. ORDINATE: INTENSITY OF THE CURRENT. UPPER CURVE: SENSITIVITY 1/50 (ORDINATE: 1 MM. = 2×10^{-7} AMP.). LOWER CURVE SENSITIVITY 1/100 (ORDINATE: 1 MM. = 1×10^{-7} AMP.).

We were not able to find these two substances ($rH = -0·23$ v. and $rH = -1·65$ v.) *in extracts from other glands.* There are, of course, reducible substances in such extracts; thus we found in some extracts from freshly prepared powdered ovaries from cows *r*H values of −0·17 v. and −1·35 v., but never values of −0·23 v. or −1·65 v.

The substance (or group of substances) characterized by $rH = -1·00$ v., the rH_2 of the total extract of the powdered ALH, described above, was also found in extracts of the pituitary posterior lobe, whether these extracts had both a hypertensive and an oxytocic effect, or only either of these effects alone.

We conclude from these experiments that in extracts from the freshly prepared powdered anterior lobe of the pituitary the gonadotropic hormone is always accompanied by a reducible group of $rH = -0·23$ v. and the thyreotropic hormone by a reducible group of $rH = -1·65$ v. Gonadotropic hormone prepared from urine of pregnant women does not contain this reducible group having an *r*H of −0·23 v. The physiological significance of these two specific reducible substances (groups) remains still to be investigated.

H. HANDOVSKY.

Pharmacological Department,
University,
Ghent.

L. HAUSS.

Laboratoires Belges
d'applications biologiques,
Brussels.
Dec. 7.

Trimethylamine Formation in Relation to the Viable Bacterial Population of Spoiling Fish Muscle

IN view of the recent communication in NATURE on this subject[1], the following comments may be of interest.

Experiments with haddocks stowed in ice[2] have shown that there is no close correlation between the viable count and the trimethylamine content of the flesh. Indeed, the content of dimethylamine, also produced from trimethylamine oxide, follows the general curve of bacterial growth much more closely[2]. Whilst it is most probably true that only certain organisms are capable of reducing the oxide, the empirical fact remains that in haddocks stowed in ice—the usual industrial preservative—the increase in content of trimethylamine has always been found to follow the organoleptic phases of spoilage in a sufficiently consistent way to render the amount of this substance present a useful index of the extent of spoilage. It would seem that, as Dr. Tarr suggests may be the case, the proportion of trimethylamine-forming to non-trimethylamine-forming bacteria is fairly constant, at least under the conditions of stowage mentioned above. The content of dimethylamine has similarly been found to be a useful index of spoilage. Indeed, reference to these two indexes together serves satisfactorily to characterize the condition of haddocks at any stage right up to the point of definite staleness.

Finally, whilst it is reasonable to assume, until the contrary is proved, that the flora of the external surfaces of all sea fish is much the same, it has been found that spoilage may pursue different courses in different species. Thus in the dogfish the contents of diamine and triamine never rise during stowage in ice to the extent that might be expected from the much larger amount of oxide present as compared with the haddock. Indeed, diamine is present only in traces during stowage for thirty days; whilst the amount of triamine is only of the same order as that found under similar conditions in the haddock. The explanation of these results may be that the large amount of ammonia formed from urea, present in much larger amounts in the dogfish than in the haddock, causes the trimethylamine oxide reducers to be overgrown by other bacteria. Certainly it has been noticed that after stowage the flora of the dogfish is considerably restricted in types as compared with that of the haddock.

In this connexion, it is of interest that Dr. Tarr's work, as reported[1], was done with smoked fish, since it is probable that the constituents of smoke effect considerable alteration in the original flora of the fish.

JAMES M. SHEWAN.

Torry Research Station,
Aberdeen. Jan. 19.

[1] Tarr, H. L. A., NATURE, **142**, 1078 (1938).
[2] Shewan, J. M., Report of the Food Investigation Board (London), Sec. 4, p. 75 (1937).

Determination of Uronic Groups in Polysaccharides

URONIC groupings occurring in polysaccharides are usually determined by measuring the evolution of carbon dioxide on heating with 12 per cent hydrochloric acid. Campbell, Hirst and Young[1] have pointed out that a small amount of carbon dioxide is liberated under these conditions from a number of pure sugars and polysaccharides in which the presence of uronic groups is not presumed, though not necessarily disproved. The evolution of carbon dioxide from certain acids that might be formed by the degradation of polyuronides was reported by Norman and Martin[2]. In an investigation of plant celluloses carried out two to three years ago at the Rothamsted Experimental Station, it was sought to establish whether the carboxyl groups demonstrably present were of the uronic type. Yields of carbon dioxide of the order of 0·2–0·3 per cent were considered to be unreliable for the reason just given, and accordingly recourse was had to the determination of the rate of evolution of carbon dioxide from such substances under standard conditions in the hope that this might be employed for demonstrating the presence or absence of uronic groups. No absolute value is involved inasmuch as it is the rate of absorption that is measured, and this is in part a characteristic of the size of apparatus in relation to the sample, the air stream, and absorbing device employed. The oil bath temperature was maintained at 140°, and a constant rate of aeration secured. The distillation was not carried out in an atmosphere of nitrogen; nevertheless the total yields of carbon dioxide from pure substances were not higher than those given by Campbell, Hirst and Young[1].

Heating was ordinarily continued for five hours, and the absorbing vessels changed every ten minutes in the first hour, every fifteen minutes in the second hour, and thereafter at thirty-minute intervals.

The rate of evolution of carbon dioxide from substances predominantly of a polyuronide nature, such as pectin, was found to be characteristic. The curve for mgm. carbon dioxide evolved per minute per gram exhibited a sharp peak between 20 and 30 minutes from time of reaching the boil. By the end of the first hour, slightly less than 50 per cent of the total carbon dioxide yield was collected. The only sugars exhibiting a sharp peak in carbon dioxide evolution were fructose and sucrose, and in these the maximum occurred earlier, between 10 and 20 minutes from time of boiling. No such sharp maximum was obtained with glucose, from which carbon dioxide was liberated only slowly. Evolution was higher in the second hour of boiling than the first, and the peak, which was ill-defined, appeared to occur at about 75 minutes. By the end of the first hour only about 15 per cent of the total carbon dioxide yield was obtained. The total yield was, in fact, difficult to establish since small quantities continued to be evolved for many hours.

The curve obtained for rice starch was of the same type as that for glucose, but that for cotton cellulose exhibited a peak in the neighbourhood of 30 minutes followed by a steady but not abrupt fall. This was more marked in a sample of Canadian spruce cellulose (not dried), which showed a second but smaller maximum at about 75 minutes. The nature of the curves was such as to suggest that they combined the effect of the uronic grouping in giving an early peak, and that of the hexose material in providing a longer and more steady evolution of carbon dioxide. Such a procedure may therefore be helpful in pointing to the probable presence of uronic groups in polysaccharides, when small quantities only are present. In addition, the total carbon dioxide evolution from a number of plant celluloses was determined.

PERCENTAGE CARBON DIOXIDE EVOLVED FROM CERTAIN CARBOHYDRATES.

		Celluloses from:	
Glucose	0·19	Wheat straw	0·30
Fructose	0·59	Rye grass	0·31
Sucrose	0·24	Oak	0·54
Rice starch	0·20	Canadian spruce	0·41
Potato starch	0·20	Jute	0·78
Cotton oxycellulose	1·29	Hemp	0·29
Esparto cellulose	0·16	Manilla hemp	0·65

In support of the conclusion that the presence of uronic groupings could be inferred from the rate of evolution of carbon dioxide, it was further established that the plant celluloses were not homogeneous with respect to groupings giving rise to carbon dioxide, and that mild acid and alkaline treatments effected a reduction in carbon dioxide yield out of all proportion to loss of weight. The following figures were obtained for Canadian spruce cellulose (carbon dioxide yield = 0·41 per cent).

(1) Residue after extraction with hot 5 per cent sulphuric acid for 1 hour, 87·34 per cent; carbon dioxide yield, 0·26 per cent.

(2) Residue after extraction with cold 4 per cent caustic soda for 2 hours, 86·40 per cent; carbon dioxide yield, 0·23 per cent.

Carbon dioxide yield on original basis from (1) = 0·22 per cent. Carbon dioxide yield on original basis from (2) = 0·20 per cent.

While no quantitative significance in terms of uronic content can be attached to very small yields of carbon dioxide from polysaccharides, the development of the procedure outlined above may permit of the demonstration of the presence of uronic groupings with a reasonable degree of certainty.

A. G. NORMAN.

Agronomy Department,
Iowa State College,
Ames, Iowa.
Dec. 30.

[1] Campbell, W. G., Hirst, E. L., and Young, G. T., NATURE, 142, 912 (1938).
[2] Norman, A. G., and Martin, J. T., *Biochem. J.*, 24, 649 (1930).

A Rapid Visual Test for Vitamin A Deficiency

A RAPID visual test for vitamin A deficiency has been described by Gridgeman and Wilkinson[1], by Haines[2], and recently by Pett[3]. In this method the patient is first asked to view a strong light (of intensity I), for a standard time T. Then this light is suddenly switched off and the time t required to see a dim light of intensity i is noted. An excessively high value of t is taken to indicate abnormality.

For the past six months I have been studying this method with the view of finding a standard method which will: (*a*) give maximum discrimination between normals and abnormals; (*b*) be applicable to uneducated people and children; (*c*) be capable of being rapidly carried out by an unskilled observer.

The most important difficulty is due to the fact that the time t can be largely influenced by factors such as intelligence, education and nervousness, as well as by vitamin A deficiency.

From my results it appears that: (*a*) if the intensity I is greater than about 100 foot-candles, the patient closes the eyes or is troubled with after-image; (*b*) to bring the eye to a definite state and to give maximum discrimination, T must be at least 150 seconds.

Since some time must be spent in making the patient accustomed to the apparatus, I do not think that a reliable indication can be obtained in less than five minutes. At present I make three tests with values of T at 30, 60, 150 sec. respectively, the total time being 7 minutes. The first two serve to make the patient accustomed to the apparatus. Also an abnormal, in addition to showing a long time (t) on the last test, usually shows a considerable difference between the second and third tests. Unintelligent or nervous normals, on the other hand, may improve between the second and third tests.

The patient has to say which of four letters he sees (*N*, *Z*, *T*, *X*). The letters are about two inches high and are viewed from 16 inches. Objects of similar size are used for children and illiterates, so that ordinary errors of vision do not affect the result.

This work is being continued by Miss E. J. Power-Steele, by whom the detailed results will be published.

R. W. DITCHBURN.

Trinity College,
Dublin.

[1] *Lancet*, I, 905 (April 16, 1938).
[2] *Trans. Ophth. Soc.*, 57, Part 1 (1938).
[3] NATURE, 142, 23 (1939).

A Specific Factor in Extracts of the Choroid Plexus Influencing the Permeability of the Myelencephalic Roof

WE have shown in earlier experiments that in chick embryos the spread of cerebrospinal fluid from the neural canal to the periaxial spaces is coincident with the development of the choroid plexuses[1], and that in rabbit, rat and guinea pig embryos, extra-cerebral spread of cerebrospinal fluid can be induced when a hypertonic saline solution is injected into the blood stream only after the choroid plexuses are differentiated[2].

In recent experiments we have shown that extracts of the choroid plexus of the rabbit, dog, cow, sheep and guinea pig contain a factor which has the following properties:

(1) It increases the intradermal spread of dyes to a degree commensurate with that of the spreading factor isolated from mammalian testis by McClean[3] and investigated by Hoffman and Duran-Reynals, Claude and Duran-Reynals and others.

(2) It is *species specific*, that is, the choroid plexus extract of rabbit gives in the rabbit a much wider dermal spread than the choroid plexus extracts of cow, sheep and dog; the choroid plexus extract of the dog produces its most extensive spread in the dog.

(3) Stale extracts are usually *less* potent than fresh extracts.

(4) By injecting chicken choroid plexus extract into the central canal of the nervous system we were able to anticipate the peri-pariaxial spread of cerebrospinal fluid. In non-injected chick embryos, the first extra-cerebral spread of fluid is seen at 7 days through the anterior membranous area of the myelencephalic roof, coincident with the development of the choroid plexus in the lateral and third ventricles. In injected chick embryos there was a quite marked extra-cerebral spread at five days, that is, two days earlier than the appearance of the choroid plexus, and a slight spread was observed in four-day embryos. Cow choroid plexus and rabbit testis extracts increased the permeability of the membranous areas but slightly and at a much later stage (5½ days).

These experiments suggest that a primary function of the glandular epithelium of the choroid plexus is to elaborate a factor which renders permeable the membranous areas of the myelencephalic roof and thus initiates the extra-cerebral escape of the fluid from the central canal.

We have found recently that extracts of the ciliary body contain a similar spreading factor, an observation which might throw light on the etiology of senile glaucoma.

HENRY COHEN.
SARAH DAVIES.

Department of Medicine,
University of Liverpool.
Jan. 10.

[1] Cohen, H., and Davies, S., *J. Anat.*, 62, 23 (1937).
[2] Cohen, H., and Davies, S., *J. Anat.*, 62, 430 (1938).
[3] McClean, D., *J. Path. and Bact.*, 33, 1045 (1930).

BIOLOGY

'Sporangial Drops' in the Mucoraceæ

IT is remarkable that such a commonplace occurrence as the natural liberation of the spores from a sporangium of *Mucor* seems not yet to have been accurately described.

The text-books either ignore the matter, or state briefly that the sporangial wall bursts, setting free the spores. Many of the figures published[1,2] show spores apparently being liberated into the air from the end of an erect and turgid sporangiophore, and there is one familiar drawing by Brefeld[3] which has been described, in at least three books[4,5,6] which have reprinted it, as of a sporangium shedding its spores. Reference to the original work, however, shows that the drawing is of a sporangium which has been crushed and treated with alcohol.

Normally, sporangia which burst in mid-air can be watched only under a low power of the microscope, as those which are within range of a $\frac{1}{6}$ in. objective almost invariably burst against the coverslip, the spores flowing out and adhering to the glass around the columella somewhat as shown in Brefeld's figure.

The conclusions I have reached after observations on the sporangia of eight species of Mucoraceæ are that, when the sporangium bursts in air and away from any solid surface, the spores are not set free when the wall breaks, nor for some time afterwards. The sporangial wall is replaced by a water surface, and the sporangium becomes a 'sporangial drop' of liquid containing the spores and columella (Fig. 1). At this stage the spores may be dispersed by contact with solid objects. Comparison may be made with the 'oidial drops' of *Coprinus* described by Brodie[7], but a similar function in relation to dispersal by flies has not been observed in the Mucoraceæ. Where the 'sporangial drops' come in contact with aerial hyphæ, they tend to run down them and collect as large irregular spore-containing drops at points where a number of hyphæ touch. Such sporangial and spore-containing drops occur in every culture in which sporangia develop to maturity; but all those observed by me have dried down into solid masses of spores firmly stuck together (Figs. 4–6). The precise conditions under which spores are distributed into the air have not yet been determined, but there is no evidence that in any of the species examined the spores are so dispersed while the sporangiophore is still turgid.

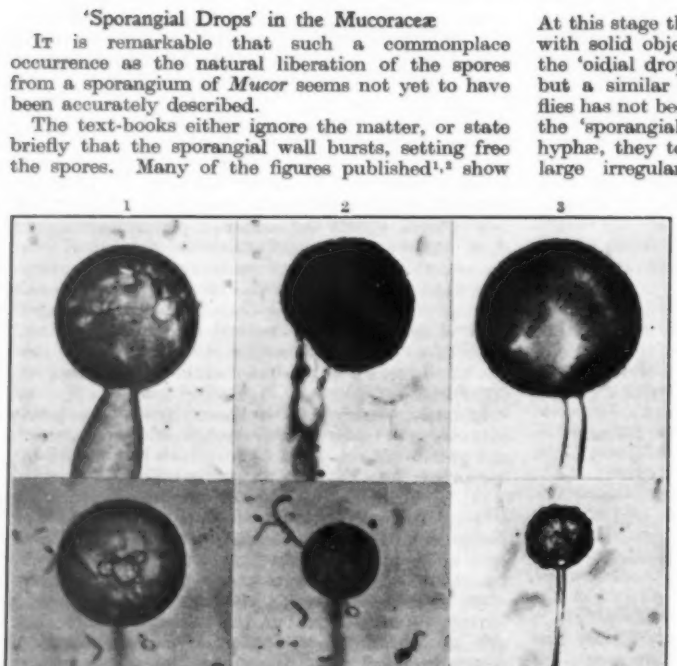


Fig. 1 (×275).
Dicranophora fulva SCHRÖT., A SPORANGIAL DROP.

Figs. 2–6 (×437).
Mucor hiemalis WEHM. 2, 3, MATURE SPORANGIA WITH (2) COLLAPSED, (3) TURGID, STALK; 4–6, A SERIES TAKEN AT 20 MIN. INTERVALS, SHOWING A SPORANGIAL DROP DRYING DOWN TO A SPORE MASS OF IRREGULAR OUTLINE.

The expansion and contraction of the liquid contents of the unseptate mycelium in response to variations in temperature cause rapid changes in the size of the sporangial drops and the turgidity of the sporangiophores. Even in a sealed cell containing a water surface, sporangiophores and other aerial hyphæ are in constant motion owing to slight temperature changes. Thus the stalk of a mature sporangium collapses, as shown in Fig. 2, after a slight fall in temperature, but regains turgidity, as in Fig. 3, when the temperature rises again. This factor is also of some importance in connexion with the growth and bursting of the sporangia.

Botany Department,
King's College,
London, W.C.2.
Jan. 12.

C. G. DOBBS.

[1] Harshberger, J. W., "Mycology and Plant Pathology", Fig. 11 (after Conn) (London, 1917).
[2] "Strasburger's Text-book of Botany", Fig. 385 (London, 6th Eng. ed., 1930).
[3] Brefeld, O., "Botan. Untersuch. ü. Schimmelpilze", 4, Taf. 2, Fig. 11 (Leipzig, 1881).
[4] v. Tavel, F., "Vergl. Morphol. der Pilze", Fig. 12, 5 (Jena, 1892).
[5] "Strasburger's Text-book of Botany", Fig. 387 (1930).
[6] Bower, F. O., "Botany of the Living Plant", Fig. 313 (London, 1923).
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Excretion of Nitrogen by Leguminous Plants

THE results of Virtanen[1] and his associates, concerning the possible excretion of nitrogenous compounds from legumes and their absorption by associated non-legumes, have not in general been confirmed. The investigations of Wilson[2], Bond[3] and ourselves[4] have

on the whole brought forward evidence contrary to that of Virtanen.

It may be generally assumed that the excretion and donation obtained by Virtanen are associated with some environmental factors not readily reproducible elsewhere.

In more recent experiments carried out at the Waite Institute, attempts have been made to grow peas and oats in association under a variety of conditions, which included variations in the amount of daylight and in the moisture content of the soil. It might be assumed that a reduction in the amount of photosynthesis in a well-established leguminous plant might result in an accumulation of nitrogen compounds above the needs of the plant, such excess being excreted and made available for any associated non-legume.

In these experiments in a series of pots, a mixture of oats and inoculated peas and oats alone were grown in pure sand under favourable conditions for a period of six weeks—the peas at the end of this period were vigorous and healthy. A differential treatment was then imposed for a further six weeks on half of the pots. These pots were allowed two hours of daylight only each day, between the hours of noon and 2 p.m. The atmospheric conditions favoured high transpiration.

Each pot contained either two oat plants alone or two oat plants and two pea plants.

TOTAL NITROGEN (MGM.) IN OAT PLANTS PER POT.

	Normal daylight, approx. 11 hours daily		Reduced daylight 2 hours daily		
Replicate	Oats alone	Oats with	Oats alone	Oats with	Mean
1	4·09	3·83	5·01	7·10	5·01
2	3·91	3·14	5·66	6·84	4·89
Mean	4·00	3·48	5·34	6·97	4·95

The standard error of a single observation is ± 0·35.

The increases in the total nitrogen content of the oats brought about by shading or by association with peas are independently significant, statistically. The legume effect is significant when the effect of shading upon the oats alone is eliminated.

In no circumstances have we ever been able to obtain evidence of donation in controlled pot experiments under the normal growing conditions in Adelaide. It is of interest that we have been able to obtain evidence of apparent donation by some modification of the local environment.

T. H. STRONG.
H. C. TRUMBLE.

Waite Agricultural Research Institute,
Adelaide.
Dec. 24.

[1] Virtanen, A. I., and Laine, T., *J. Agric. Sci.*, **27**, 332 (1937), etc.
[2] Wilson, P. W., NATURE, **140**, 155 (1937).
[3] Bond, G., *Ann. Bot.*, n.s., **2**, 61 (1938).
[4] Trumble, H. C., and Strong, T. H., *C.S.I.R. (Aust.) Bull.*, **105**, 11-24 (1937).

Respiration Changes following Irradiation with X-rays

IN a study of respiratory changes prior to tumour formation after irradiation with X-rays, two disturbances in the oxidation processes of the affected tissues were observed. A group of sixteen mice were given local treatment of X-rays sufficient to produce a burn. At various intervals after irradiation (3 hours–50 days), mice were successively sacrificed and the respiration of the irradiated area compared to the respiration of an equal control area on the same mouse. It was observed that, after the first day of irradiation, the respiration began to decrease, reaching a maximum depression, after about two weeks, of 60 per cent below the respiration of the control skin. Directly following this period of inhibition was a period of stimulation which brought the oxygen consumption of the irradiated area of skin about 35 per cent above that of the control. This stimulation continued over a period of about five weeks.

It has not been determined at this time whether the initial decrease in oxygen consumption is due to a degeneration and dying of the irradiated cells, and the subsequent stimulation of respiration due to an invasion of leucocytes and new tissue cells, or whether irradiation has more directly altered the respiratory mechanism of the cells.

These results are of particular interest in view of the experiments of Davis[1], which show that the resistance or susceptibility of animals to cancer is dependent upon the respiration of the normal tissues of these animals. There also remains the possibility that a relationship exists between tissue respiration and lymphocytic invasion; for it has been demonstrated by Murphy *et al.*[2], that when lymphocytosis is prevented by proper dosages of X-rays, the resistant state is abolished. Erythema doses (Murphy[3]), however, considerably reduce the percentage of 'takes' of autografts.

The fact that X-rays can both stimulate and depress tissue respiration may explain why X-rays can both decrease and increase the resistance of animals to transplantable tumours.

JOHN C. FARDON.
WILLIAM A. SULLIVAN.

Institutum Divi Thomae,
Cincinnati,
Ohio.
Dec. 17.

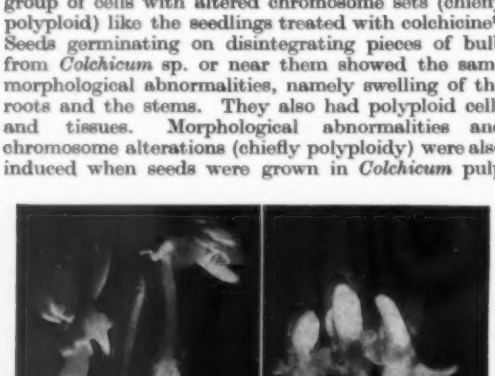
[1] Davis, J. E., *Canadian Med. Assoc. J.*, **36**, 27-30 (1937).
[2] Murphy, James B., and Morton, John J., *J. Exp. Med.*, **22**, 204 (1915).
[3] Murphy, James B., Maisin, Joseph, and Sturm, Ernest, *J. Exp. Med.*, **33**, 645 (1623).

Induction of Polyploidy by Pulp and Disintegrating Tissues from *Colchicum* sp.

INVESTIGATIONS of the active agents in Nature inducing chromosome alterations have shown that the most effective ones are abnormal temperatures[1] and obviously various parasites (cynipid wasps[2], nematodes[3], *Eryophyes*[4], *Tetranychus*[5], bacteria[6], fungi[7], viruses[8], etc.). The latter induce abnormalities in the mitotic and meiotic processes chiefly by introducing various substances and partly by woundings, which further give rise to plants with altered chromosome complexes (including polyploidy[9]).

This type of work in connexion with the induction of chromosome alterations (chiefly polyploidy) by the alkaloid colchicine[9] obtained from *Colchicum autumnale* suggested the following experiments: (1) Does pulp from *Colchicum* bulbs induce chromosome alterations? (2) Do disintegrating pieces from the bulbs induce chromosome alterations and particularly polyploidy in seedlings from germinating seeds in the neighbourhood? Experiments performed showed that about two grams of pulp from *Colchicum* sp. bulb induced swellings (like low concentrations from colchicine-induced) in seedlings when seeds from *Triticum*, *Secale* and *Crepis* were germinating on the

pulp, covered with filter paper in Petri dishes. The seedlings that developed at a distance of 1·5–2·5 cm. from the pulp in the dishes showed similar symptoms. Morphologically abnormal seedlings had cells and group of cells with altered chromosome sets (chiefly polyploid) like the seedlings treated with colchicine[9]. Seeds germinating on disintegrating pieces of bulb from *Colchicum* sp. or near them showed the same morphological abnormalities, namely swelling of the roots and the stems. They also had polyploid cells and tissues. Morphological abnormalities and chromosome alterations (chiefly polyploidy) were also induced when seeds were grown in *Colchicum* pulp



(*a*) (*b*)

(*a*) IN THE MIDDLE—A NORMAL (CONTROL) ROOT FROM A WHEAT SEEDLING; ON EACH SIDE, ROOTS FROM SEEDLINGS GROWN (LEFT) ON *Colchicum* PULP AND (RIGHT) AT A DISTANCE OF ABOUT 2 CM. FROM THE PULP IN PETRI DISH WITH FILTER PAPER. (*b*) RIGHT, A NORMAL WHEAT SEEDLING; THE OTHER TWO, GROWN ON PULP FROM *Colchicum*.

mixed with sand in pots or on disintegrating pieces of various size from *Colchicum* in pots with soil and sand. These observations show that: (1) Pulp from *Colchicum* bulbs can be used for experimental production of polyploid plants. (2) Disintegrating bulbs from *Colchicum* inducing chromosome alterations in laboratory conditions should also cause the same phenomenon in Nature.

The foregoing investigations suggest searching for polyploid forms among the plant species living in Nature together with *Colchicum*.

DONTCHO KOSTOFF.

Institute of Genetics,
Academy of Sciences of U.S.S.R.,
Moscow.

[1] Extensive literature list, see in Kostoff and Sarana, *J. Genetics* (in the Press).
[2] Kostoff and Kendall, *Biol. Bull.*, **56**, 402–459 (1929).
[3] Kostoff and Kendall, *Zentralbl. f. Bakter.*, II Abt., **81**, 86–90 (1930).
[4] Kostoff and Kendall, *J. Genetics*, **21**, 113–115 (1929).
[5] Kostoff and Kendall, *Genetica*, **12**, 140–144 (1930).
[6] Kostoff and Kendall, *Science*, **76**, 144 (1932); *Archiv. f. Mikrobiol.*, **4**, 487–508 (1933); *Gartenbauwissensch.*, **9**, 20–44 (1934).
[7] Kostoff, *Ann. Agr. Fak. Sofia Univ.*, **8**, 317–324 (1929–30).
[8] Kostoff, *Genetica*, **15**, 103–114 (1933); *Phytopathol. Z.*, **9**, 387–405 (1936); *Current Sci.*, **6**, 555–556 (1938).
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Transformation *in vitro* of Cultures of Normal Cells Treated with Rous Sarcoma Agent into Sarcoma Cultures

THE procedure adopted for the cultivation of the Rous sarcoma *in vitro* in accordance with the usual method described by A. Fischer[1] is as follows: A fragment of tumour is incubated in a medium consisting of chicken plasma and dilute embryonic extract. After a time the growing culture begins to digest the surrounding medium and also itself. Such a culture will die out if it is not provided with fresh tissue by means of subculture. The sarcoma cells infiltrate the added tissue fragment within which they remain for a time embedded. If normal tissue is regularly added, the sarcoma cells can be cultured over an unlimited period and will retain their malignancy.

Since A. Fischer succeeded in culturing sarcoma tissue by the addition of dead tissue (kept in 'Tyrode' in the refrigerator for a month), it might be assumed that the added tissue has a mechanical and perhaps nutritive function in the cultivation of sarcoma, and that the growth of sarcoma *in vitro* depends solely on the continuous multiplication of the original malignant cells. On the other hand, the early experiments of A. Carrel[2] and those recently published by Ludford[3] show that the Rous sarcoma agent as such is capable of 'infecting' normal cells *in vitro*. We therefore felt justified in assuming that in *in vitro* cultivation of sarcoma according to the methods described above, some process may be taking place in addition to the multiplication of the original sarcoma cells. It may be assumed that the normal cell material which is added is influenced by the agent present in the original sarcoma culture and as a result there is, in addition to a multiplication of sarcoma cells, a constant process of 'cancerization' of the newly added normal tissue.

The first essential in the clearing up of this problem experimentally is the definite separation in culture of agent from the multiplying sarcoma cells. We have succeeded in separating agent from living cells *in vitro* by irradiating cultures with radium.

The relationship between the dose needed to kill cells and that needed to destroy the agent in Rous sarcoma cultures was established accurately. It was, therefore, possible to kill the cells without appreciably impairing the activity of the agent.

An eight-year-old Rous culture strain given us by A. Fischer was used for the experiments. A radium plate containing 6 mgm. of radium was employed, the β-rays being used[4,5].

The experiments have shown that the addition of a fragment of tissue or of a pure culture of normal fibroblasts to an irradiated culture of Rous sarcoma, which had received double the dose needed to kill the cells (under the conditions of our experiments this involves an irradiation time of seventy-two hours), results in an invasion of the normal cells by the still active agent. On subculture in a hanging-drop, such a cell colony carrying agent acquires all the known morphological and physiological properties of a real Rous sarcoma culture (typical cell forms, autolytic power, typical behaviour with added cell material). Inoculation into a fowl always proves such a culture to be malignant, causing a typical sarcoma. The use of strongly irradiated cultures causes the 'cancerizing' process to last longer, and the transformation of normal cell colonies in Rous sarcoma cultures manifests itself only after 6–8 passages.

Details of our work will shortly appear elsewhere.

Cancer Laboratories,
Hebrew University,
Jerusalem.
Jan. 5.

L. HALBERSTAEDTER.
L. DOLJANSKI.

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[2] *J. Exp. Med.*, **43**, 647 (1926).
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[5] *Arch. exp. Zellforschg.*, **19**, 475 (1937).

Epidemiology of Yellow Fever

URBAN outbreaks of yellow fever are brought to an end either by the eradication of the mosquito vector, *Aëdes* (*Stegomyia*) *aegypti*, or by the immunization of a high percentage of the human population. Rural outbreaks are less easily controlled, for in yellow fever areas both in Africa and South America 20–25 per cent of wild monkeys are found to possess immune bodies to yellow fever; in South America, in addition, the so-called jungle yellow fever is transmitted by non-domestic forest-living mosquitoes. Although mosquitoes once capable of transmitting yellow fever by bite appear to remain infective, their life span is short and they are unable to transfer the virus to other mosquitoes either by contact or hereditarily through the egg. If the mosquito-man and mosquito-monkey cycle of transmission represents the complete epidemiological picture of yellow fever, it is not easy to account for the persistence of infection in rural areas during dry seasons when adult mosquitoes are either absent or are present only in very small numbers. It has therefore been suggested that other arthropods may possibly harbour the yellow fever virus, such arthropod vectors either having a longer life than ædine mosquitoes or being able to transmit the virus hereditarily. So far, no biting arthropods other than mosquitoes have been found of importance in the epidemiology of yellow fever.

Two recent observations, however, suggest that it may be necessary to consider non-biting arthropods as possible vectors of yellow fever. In the first place, it has been found possible to infect monkeys with yellow fever by the alimentary canal. When yellow fever virus was introduced by means of a soft catheter into the stomachs of Indian monkeys (*Macaca mulatta*) and African monkeys (*Cercopithecus aethiops*), the virus passed into the blood stream and, in the case of Indian monkeys, caused fatal infection. Similar attempts to infect by the alimentary tract failed in man, dog, rabbit, guinea pig, rat, mouse, hen and pigeon. In the second place, it has been shown that when yellow fever virus is injected into the abdomen of the cockroach, *Blatella germanica*, kept at 19° C., the virus retains its activity certainly for fifteen days. Though it is not suggested that the cockroach necessarily plays any part in the epidemiology of yellow fever, it has long been known that both African and South American monkeys supplement their mainly vegetarian diet by grubs and insects. Precise data as to the insects eaten are, however, lacking; but in view of the observations described, it would be of considerable interest to determine what animal foods are actually eaten under natural conditions by monkeys in the yellow fever areas of Africa and South America.

G. M. FINDLAY.
F. O. MACCALLUM.
Wellcome Bureau of Scientific Research,
London, N.W.1. Jan. 2.

Kinetochore or Centromere?

FEW questions in cytological terminology can have caused more disagreement and disorder than that of the name to be applied to the portion of the chromosome which determines its movements on the spindle. The names given to this body have been many, and Dr. Schrader's appeal[1] for the general adoption of one term, with the abandonment of all others, must be received sympathetically by cytologists and geneticists. He proposes, however, the adoption of the term 'kinetochore', saying that it has been employed by Sharp in his text-book[2]. Sharp certainly recommends the term in a footnote, but he has not, so far as I can observe, carried out his own recommendation. Schrader's alternative proposal is to introduce yet another new term.

Where there exist two or more names for an organ, it is generally found that one of them gradually ousts the rest and becomes established as the accepted term. This process of selection may be seen at work in the special case to which Schrader directs attention. Of the innumerable names which have been proposed, only two main forms appear commonly in present-day literature. One of these, the old term 'spindle fibre attachment', with its variants, is clumsy, somewhat misleading and highly inadaptable. Doubtless it will be discarded in time. The other, Darlington's 'centromere', implies a visible particle instead of a dubious relationship, and has many advantages, being intelligible, pronounceable and adaptable. The adjectives 'acentric', 'dicentric', etc., which are so easily derived from the name 'centromere' add materially to its value. There can be little doubt that it is the best term in use to-day. Dr. Schrader would appear to agree with this statement, as of all the terms he wishes to discard, 'centromere' is the only one for the rejection of which he gives detailed reasons. These are two: (1) that the word has been used earlier in a different connexion by Waldeyer, and (2) that 'centromere' is likely to be confused with 'centrosome', 'centriole', etc.

Now Wilson's glossary, so long ago as 1925[3], gives Waldeyer's usage as obsolete, so the first objection can carry little weight. Secondly, the confusion between 'centromere', 'centrosome', etc., is likely to be no greater than that between 'chromomere', 'chromosome', 'chromatin', 'chromatid' and 'chromonema', all of which are in common use to-day and do not, so far as I am aware, cause any serious difficulty. The lack of weight of Schrader's objections is further shown by the growing popularity of the term 'centromere'. Since its inception in 1936, it has come to be used not only by the English authors admitted by Schrader, but also by many others. In recent papers, Muller[4], Sax[5], Stone[6], Kostoff[7], Geitler[8], Levan[9], Satô[10], Klingstedt[11], Husted[12], Matthey[13] and Parthasarathy[14] all employ this name, some for cytological and others for genetical purposes.

Thus it appears that Darlington's term is doing all that Schrader desires. Its use is growing rapidly, and we may look forward with reasonable confidence to the time when, by its own merits, it will have replaced the ten or more other names. To introduce 'kinetochore', or some entirely new word, would be to confound further the present confusion and to delay the achievement of the unanimity which Schrader so reasonably advocates.

K. MATHER.
John Innes Horticultural Institution,
Merton, London. Jan. 28.

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Points from Foregoing Letters

THE radium content of sea water is found by E. Föyn, B. Karlik, Prof. H. Pettersson and E. Rona to vary between 0·03 and 0·2 × 10^{-12} gm. per litre. Even the larger figure corresponds to only about one fifth the amount to be expected from the uranium present in sea water (2 × 10^{-6} gm. per litre), and the authors consider that the larger part of the radium (or rather its parent ionium) is precipitated together with iron in clays and other marine deposits. The same occurs to a lesser extent with thorium, of which only half the expected amount is found in the sea water.

By bombarding a uranium-lined ionization chamber, connected to a linear amplifier, with neutrons from a radium-beryllium source, Dr. O. R. Frisch has been able to detect ionizing particles of atomic weight of at least seventy. This indicates a break-up of the uranium nuclei into parts of comparable size, as foreshadowed by the experiments of Hahn and Strassmann.

Dr. H. J. Bhabha argues that the fundamental length determined by the mass of the mesotron (meson) does not set a limit to the accuracy of quantum mechanics and that it is possible to calculate the production of large nuclear explosions, to a high degree of accuracy, by treating the meson field quantities classically.

Prof. V. Henri and Dr. E. Bergmann report that 9-cyclohexenyl-phenanthrene and 9, 9′-diphenanthryl show a spectrum practically identical with that of phenanthrene, while 9-cyclopentenyl-phenanthrene, in spite of its similar structure, has a much more diffuse spectrum. An analogous difference between these compounds is found in their chemical behaviour.

Dr. W. O. Williamson indicates a simple process for obtaining titanium dioxide which shows rapid darkening in daylight.

Photographs obtained with the electron microscope are submitted by Dr. M. Benjamin and R. O. Jenkins showing that within the temperature range of 1,000–1,050° K. barium spreads uniformly over the surface of molybdenum wires. Above 1,050° K., barium evaporates rapidly.

Vitamin B_1 (thiamin) brings about the combination of inorganic phosphate with adenylic acid, when pyruvic acid is present (both in the presence and absence of air), according to experiments by Prof. F. Lipmann. The dehydrogenation of pyruvic to acetic acid (through the agency of thiamin pyrophosphate) supplies the energy necessary for the phosphorylation of adenylic acid. This newly discovered coupled reaction may be of importance as a source of muscular energy, and may account for the effect of vitamin B_1 on the heart.

A. E. Axelrod and Prof. C. A. Elvehjem state that they have shown a decrease in the cozymase content of the liver and muscle of pigs and dogs deficient in nicotinic acid.

Experiments with rats carried out by Prof. B. Zondek indicate that when the sex hormone, progesterone, is injected into the organism, it is progressively inactivated; four fifths of the quantity injected disappeared within 24 hours, although the physiological effects of the hormone upon the organism only occur 100 hours after injection.

Polarographic curves (obtained with a dropping mercury electrode) of extracts of anterior pituitary lobe are submitted by Prof. H. Handovsky and L. Hauss, indicating the presence of three reducible substances or groups, with oxidation-reduction potentials of rH = −0·23, −1·00 and −1·65 volts respectively. From these and other experiments the authors conclude that in extracts from freshly prepared powdered anterior lobe of the pituitary the gonadotropic hormone is always accompanied by a reducible group of rH = 0·23 v. and the thyreotropic hormone by a reducible group of rH −1·65 v.

Commenting on Dr. H. L. A. Tarr's communication on trimethylamine in spoiling fish, Dr. J. M. Shewan states that in haddocks preserved in ice the increase in the amount of trimethylamine may be considered a useful guide of the extent of spoilage.

Although the evolution of small amounts of carbon dioxide from polysaccharides on boiling with 12 per cent hydrochloric acid cannot be taken as evidence of the presence of uronic groupings, according to Prof. A. G. Norman, the determination of the rate of evolution under standard conditions may make it possible to decide their presence or absence. Carbon dioxide is liberated at different rates from polyuronides, and from sugars or polysaccharides not containing uronic groups.

Prof. R. W. Ditchburn discusses a visual method for testing vitamin A deficiency, with special reference to certain precautions necessary to obtain reliable results.

Prof. Henry Cohen and Miss Sarah Davies discuss the properties of extracts of the choroid plexus in different species. They find that in the chick this extract increases the permeability of the myelencephalic roof and they suggest that the secretion of the choroidal epithelium is the factor initiating the periaxial spread of cerebrospinal fluid in the embryo.

Observations by Dr. C. G. Dobbs show that when the sporangia of Mucors burst in air they give rise to 'sporangial drops' which dry down into solid spore masses. Spores are not liberated directly into the air, as figured in many text-books.

By reducing the exposure to sunlight of pea-plants previously exposed to the normal amount of daylight, Dr. T. H. Strong and Dr. H. C. Trumble have been able to confirm the excretion of nitrogen by the roots of these leguminous plants, as discovered by Virtanen.

A method is indicated by Dr. L. Halberstaedter and Dr. L. Doljanski for the separation of virus from living cells in cultures of Rous sarcoma *in vitro* by means of irradiation with radium. It has been possible to transform *in vitro* normal tissue into typical Rous sarcoma colonies through the action of agent freed from living cells by means of radium rays. From this it is concluded that, in the usual method of cultivation of the Rouss arcoma *in vitro*, there takes place a constant transformation of the added normal tissue into Rous sarcoma, in addition to the multiplication of the original Rous sarcoma cells themselves. Fibroblasts in pure culture too, may, under given conditions, undergo transformation into sarcoma cells through the action of agent.

Obituary Notices

Prof. Henry Balfour, F.R.S.

In Spencer's "Last Journey" (Oxford, Clarendon Press, 1931), Plate II, will be seen the reproduction of a photograph of Moseley's 1884 biology class at Oxford. The strikingly handsome young man at the very back of the group—he may be distinguished by the rabbit that he is holding in his hand—is Henry Balfour; Baldwin Spencer, Bourne, Hickson, Roth, and other contemporaries also figuring there. That was a momentous year for Balfour, because Moseley induced him, together with Spencer, to help to arrange the collections just then bestowed on the University by General P. H. Rivers at the instance of his friend Tylor. Nine years later, Balfour was appointed curator of the Museum that had meanwhile been fitted out to house and display the rapidly increasing array of ethnological material; and for the forty-six years to come presided, more or less despotically, over the destinies of a treasure-house henceforth filled to bursting point with the spoil of the primitive world.

Though he never limited the range of his biological interests, and numbered both ornithology and geographical exploration among his enthusiasms, Balfour stuck indefatigably to his main business of studying the earlier arts and crafts of mankind according to the comparative method. He had indeed inherited from Pitt-Rivers and Tylor a system of classification somewhat apt to suggest that evolution is a unilinear process. Yet Balfour himself was never under any illusion as to the vagaries attending the propagation of culture, whether technologically considered or in general. Thus his numerous papers—would that he had found the time to compose a systematic treatise on the subject—are primarily concerned with problems of distribution. Before origins can be determined, he would argue, and in order to settle once for all the parts severally played by borrowing and by independent invention, let us exhaustively chart the actual positions in time and space that the evidence enables us to assign to each of our hypothetical types.

Though rarities may gladden the heart of the keeper of a museum, the scientific value as such of Balfour's acquisitions consists rather in a well-authenticated *provenance* warranting their inclusion in some homologous series. Thus when from 1908 onwards Oxford maintained a diploma course in anthropology under the direction of a triumvirate of whom Balfour was one, he fully justified as a lecturer his claim that, despite the wide scope of the physical and social branches of the subject, technology should have strict parity; for he could exploit the educational possibilities of this *tertium quid* as well as any man of his time. Though in the matter of prehistoric archæology his museum had to share honours with the Ashmolean, he controlled enough material to be able to demonstrate the relations between ancient and modern prehistory; and indeed nowhere was the doctrine of the age-long continuity of human development better supported by ocular proofs.

To speak of Oxford's debt to Balfour is partly a domestic matter, and, in view of the financial aid forthcoming from the University, it is better not to inquire into the extent of his private benefactions, if indeed Alma Mater can blush. But it is public knowledge that his exploration of the implementiferous gravels of the Victoria Falls, or, again, his travels in Australia, Assam, West Africa and elsewhere, whence his friends so willingly consented to have their pockets picked, made his show-cases the envy of rival institutions. For he had that flair which must ever be the supreme gift of the collector, and could tell at a glance the precise worth, in a scientific and no merely commercial sense, of each scattered piece of material evidence which presently would be fitted into some mosaic revealing a distinctive pattern. Extremely critical, he was slow to construct; but in the independent way of the Scot he could be very tenacious of a formed opinion, if only because of the sufficiency of the knowledge on which it rested. Moreover, his mind had a strong ally in his hand; for he drew beautifully, and had a sound working acquaintance with primitive processes of all kinds, from fire-making to flint-knapping. Altogether, he was a master of his trade, and there are not many like him in the world to provide a fit successor. For the rest he was a very gallant gentleman, whose candid and courteous nature endeared him to his many friends.

Balfour died on February 9 at the age of seventy-six years.

R. R. MARETT.

Prof. Gustav Tammann

WE regret to announce the death in Göttingen at the age of seventy-eight years of Geheimrat Prof. Gustav Tammann, whose researches in the Universities of Dorpat-Jurjew and Göttingen on metallography and the properties of the crystalline and amorphous states of matter have proved to be of far-reaching importance both to pure science and to the metallurgical and glass industries.

Tammann began his life's work after the main laws of heterogeneous equilibria had been propounded by Willard Gibbs and developed by Roozeboom, and his contribution has been that of providing the systematic experimental knowledge and detailed interpretation of heterogeneous systems necessary to establish the thermodynamical reasoning in men's minds as of some value in everyday affairs. One of his first interests was the study of the discontinuities arising during the changes of state in condensed systems, and he devised experimental technique for following such changes over a wide range of temperatures and up to pressures of 10,000 kgm. One of his noteworthy discoveries in this field was that ice,

under high pressure, could occur in several different crystalline forms.

In his search for generalizations concerning the equilibria between solids and liquids, Tammann carried out investigations on supercooled liquids, and these led to fundamental discoveries on the nature of glasses. He measured the rates of crystallization and rates of appearance of nuclei in supercooled liquids, and correlated these properties with the rate of development of heat and the changes in viscosity that occurred. His work on silicates in the crystalline and amorphous conditions has also been of value in pointing the way for the development of geochemical and geophysical ideas.

Tammann is, perhaps, best known for his work on metallography, for the reason that this branch of his activities has had the more immediate practical application. Combining microscopical investigation with the determination of the melting point curves of metallic systems, he laid bare the secrets of many two- and three-component systems, and many intermetallic compounds. He investigated the internal structures of metallic alloys, their electrical and magnetic properties and the changes in properties which occur on cold working and during recrystallization. His work on the amorphous state led him to appreciate the significance of order and disorder in the crystalline state, and he was the first to show that the chemical properties of solid solutions were dependent on the arrangement of the atoms in the lattice. His conclusions in this field have formed the basis of much modern theoretical work, and have proved of very great significance in the metallurgical industries.

As a teacher of physical and inorganic chemistry, Tammann's influence has permeated the scientific world. Throughout a very long life, he had a very large research school, in which were represented many students from far afield, and his monographs under the titles "Kristallisieren und Schmeltzen", "Metallographie" and "Aggregatzustände" led to many developments in other hands. His interest in chemical industry was shown by the numerous technological discussions in which he took part, and by the trend of his metallographical work. He played a very active part in the development of the *Zeitschrift für physikalische Chemie*, the *Zeitschrift für anorganische Chemie* and the Bunsen Gesellschaft. His work was recognized by numerous honours both at home and abroad, and in his seventy-fifth year he was awarded the Adlerschild of the German Reich, with the inscription "Altmeister der Deutschen Metallurgie". By future generations, he will be remembered by his contributions to the development of the practical arts, and in this respect he deserves to rank with Agricola, the renowned metallurgist of the sixteenth century. W. E. G.

Dr. J. E. R. Constable

THE sudden death of Dr. J. E. R. Constable on February 3 came as a great shock to his friends. Dr. Constable, who was only thirty-two years old, was a senior scholar at Trinity College, Cambridge, and obtained first class in both Parts I and II of the Natural Sciences Tripos. Thereafter, he spent three years as a research student at the Cavendish Laboratory, mainly devoting himself to the application of electrical methods of detecting single particles, in the study of the artificial disintegration of the elements, work necessitating much patience and sound judgment. This investigation brought him his Ph.D.

In 1931, Constable joined the staff of the National Physical Laboratory, where he was attached to the Sound Section of the Physics Department. He soon proved himself a valuable member of the team of acoustical workers who were endeavouring to unravel the entangled phenomena associated with building acoustics, more particularly as regards the transmission and abatement of noise, both air-borne and impact.

Constable was an ingenious and all-round physicist with an original and receptive outlook. His energy and enthusiasm were contagious: he had a great aptitude for getting things done, and could speedily improvise effective equipment and demonstrations. He revealed a cheery and agreeable freshness of style when lecturing or expounding a paper. When he died, as he did in full harness, he had a book approaching completion; and some twenty published papers and articles, singly or jointly, stood to his credit, most of them relating to building acoustics. One may perhaps refer to his valuable and eminently practical investigations on the optimum sound insulation of double windows and composite partitions; the influence of the obliquity of an incident sound beam on the insulating value of a solid partition; the vibration patterns of walls when transmitting sound; the flanking conduction of sound from room to room in a building; and the reduction of noise transmitted along water pipes.

There was assuredly a successful career in front of Constable, had he been spared. I write with a sense of keen personal loss, for we had done much together. This loss is shared by all his colleagues, who will long remember with affection his frank and friendly disposition and his very likeable personality. We offer our profound sympathy to his widow who, herself a former research student at the Cavendish Laboratory, actively co-operated in her husband's acoustical interests. There is one young son.

G. W. C. KAYE.

WE regret to announce the following deaths:

Prof. Karl Schröter, emeritus professor of botany in the Federal College of Technology, Zurich, aged eighty-four years.

Prof. A. Smithells, C.M.G., F.R.S., emeritus professor of chemistry in the University of Leeds, director of the Salters' Institute of Industrial Chemistry during 1923–1937, on February 8, aged seventy-eight years.

Prof. S. P. L. Sörensen, director of the Chemical Department of the Carlsberg Laboratory, Copenhagen, honorary fellow of the Chemical Society, aged seventy-one years.

News and Views

Dr. Alfred Harker, F.R.S.

On February 19, Dr. Alfred Harker, emeritus reader in petrology in the University of Cambridge, attains his eightieth birthday, and petrologists throughout the world will join in offering their congratulations. Graduating from St. John's College in mathematics in 1882, he had already come into contact with Prof. McKenny Hughes, and was shortly appointed to the staff of the Woodwardian Museum. His earliest original work dealt with the development of cleavage in slates; but he soon turned to petrographic work on the igneous rocks of North Wales, with a series of publications culminating in the Sedgwick prize essay on "The Bala Volcanic Series". In the Lake District, he began (with J. E. Marr) a study of the Shap granite and its aureole, and later of Carrock Fell. During this period also appeared the first edition of "Petrology for Students", now in its seventh edition. From 1895, Harker was for ten years attached to the Scottish branch of the Geological Survey of Great Britain, and worked in Skye and the Small Islands of Inverness-shire, collaborating in the production of the official maps and memoirs, and writing a special memoir on "The Tertiary Igneous Rocks of Skye". Much of this work was necessarily descriptive, and the genetic considerations to which it gave rise were brought together in "The Natural History of Igneous Rocks", a pioneer work on petrology in its treatment of rock-magmas as complex solutions. As president of the Geological Society, he expanded further in his address in 1917 the significance of igneous activity as an integral part of the historical geology of Britain. The central themes of his address the following year, that metamorphism is to be conceived as a progressive change, and that Great Britain offers unique opportunities to investigate such changes, find fuller expression in his book, "Metamorphism", published in 1932. Since his retirement, Dr. Harker has remained actively associated with the petrological collections at Cambridge, where the Harker collection of rock-slides now numbers forty thousand sections. He was awarded the Wollaston Medal of the Geological Society of London in 1922 and a Royal Medal of the Royal Society in 1935.

Prof. František Nušl

In honour of Prof. F. Nušl, director of the National Observatory of Prague and professor in the Charles University, who has entered on his seventieth year, a composite work has been compiled with the title "Práge věnované Dr. Františku Nušlovi". Prof. Nušl's interest in astronomy is well known; he was vice-president of the International Astronomical Union for the Leyden meeting held in 1928. His circum-zenithal instrument for the determination of time was described before the Czech Academy in Prague (see NATURE, **68**, 376; 1903) and also in a number of other papers. Twelve authors have contributed to the volume and their papers embrace a wide range of subjects. Z. Kopal discusses the two-bodies problem where the central body is an oblate spheroid, not homogeneous, and shows that a steady advance of periastron will take place. V. Guth develops a graphical method for determining the heights and paths of meteors, and J. Štěpánek has a most interesting paper showing the results of photographing Comet Finsler (1937 *f*) from July 13 until August 15, 1937. It is easy to follow the developments of various parts of the head and tail of the comet by examining these photographs, and also the variations of the different luminous rays. J. Procházka explains his method for investigating the stability of the Bouty meridional telescope at Paris by means of two auxiliary telescopes provided with micrometers, and has found that the stability of the instrument is excellent. J. Svoboda supplies a detailed account of his experimental method for finding the personal error in observations with the Nušl-Frič circum-zenithal instrument. Z. Horák deals with Svoboda's method for determining the radiant of a meteor stream with a minimum of error, and towards the end of his paper shows how very satisfactory results can be obtained by a graphical method. These as well as the other papers, with all of which it is impossible to deal in the limited space, form most interesting reading.

Centenary of the Cell Theory

The centenary of the cell theory is marked by an article from the pen of Prof. William Seifriz, professor of botany in the University of Pennsylvania, in the recent issue of *Chronica Botanica* (**4**, No. 6, December 1938). The original theory as propounded by Schleiden and Schwann was faulty; but the immediate theory was, like many other theories, of far less value than the truths which it has been instrumental in ultimately bringing to light. The authors advanced the theory that all organisms are aggregations of structural units or cells; but in his cautiously worded article Prof. Seifriz warns biologists that disciples of the theory tend to attach far more meaning to this than perhaps even its originators intended. The theory established a universal principle of development in living matter; to follow the principle slavishly, in the light of modern knowledge, is wrong; but there is, according to Prof. Seifriz, a tendency to do so. Many biologists seem averse to remoulding their speculations with the advancement of knowledge. Another weakness in the theory is that the cell is viewed as an elementary individual with an autonomy all its own. But this conception is very limited, since the cell is invariably influenced by its environment, such as solutions, temperature, and even the proximity of other cells. That is, the cell is far more plastic than the cell theory would

allow. As Prof. Seifriz emphasizes: "The laws of science as formulated by man are to be commended, even the worst of them, because of the influence they have on further speculation, but they are at best but speculations. . . . In this light must we view the cell theory. Flexibility in thinking comes through mellowness in character and greater willingness to view matters philosophically."

IN a less critical, though historically more detailed, article, in the recent issue of *Current Science* (7, No. 6, December 1938), Mr. E. W. Melson, of the Bausch and Lomb Optical Co., Rochester, New York, claims that the cell theory has been followed by such a wealth of confirmation that we are justified to-day in rating it as the most fundamental concept in the whole science of modern biology. He gives interesting facts concerning the aberrations on cells made by Hooke, Swammerdam, Malpighi, Van Leeuwenhoek and Wolff. They, together with others mentioned, collected much data concerning cells. They undoubtedly saw them and probably their nuclei; but the significance escaped them. Dutrochet published in the eighteen twenties much material which showed his clear conception of the anatomical identity of the cell. In fact, it seems that it was Dutrochet's experiments on physiology which made the recognition of the cell as a structural, functional and developmental unit a necessity. But the nucleus was left out. Schleiden's greatest contribution rests on his recognition that increase in the size and number of cells is responsible for growth, and Schwann's his statement that "The elementary parts of all tissues are formed of cells in an analogous, though very diversified manner, so that it may be asserted that there is one universal principle of development for the elementary parts of organisms, however different, and that this principle is the formation of cells. . . ." But we feel, with Prof. Seifriz, that biologists tend to be incautious of the theory, especially in elementary biological teaching, and do not realize sufficiently that neither Schleiden nor Schwann had at their disposal present-day knowledge of nuclear structure, mitotic division and all the modern concepts in genetics and cytology.

Evidential Value of Blood Groups in Litigation

THE debate on the second reading of the Bastardy (Blood Tests) Bill, introduced by Lord Merthyr, which took place in the House of Lords on February 8, was no less noteworthy for the tribute paid by Viscount Dawson of Penn to the work of Mendel in the study of inheritance than for the cogency of the arguments with which his Lordship supported the objects of the legislation proposed. Clause 1 of the Bill states that in applications for affiliation orders a court may, and at the request of either party shall, order a test to be made of the blood of all three parties in the case. Lord Dawson's insistence on the urgent desirability of substituting objective evidence for the human and subjective in this class of legal action, which is peculiarly open to the danger of a miscarriage of justice—a contention in which he was followed with characteristic vigour by Lord Raglan—will be welcomed by all who concur in the view that the scientifically attested fact is the surest guide to right judgment. At the same time his recapitulation of the scientific evidence, on which confidence in the blood group test is based, will both inform public opinion as to its potentialities, while removing certain popular misconceptions as to its scope by the emphasis laid on its limitations. It was pointed out by both Lord Merthyr and Lord Dawson that the blood test provides no more than negative evidence, that is evidence of non-paternity, to the extent, it is estimated, of 30 per cent of innocent men. In the course of the debate it was pointed out that the application of the test in this connexion had been widely adopted in other countries and its supporters "were culled not from the scientists of one country, but from the whole civilized world". "It was," it was said further, "a slur on the medicine and law of this country that we were so long in adopting something so completely proved". The Bill was referred for inquiry to a Select Committee of the House; but the Lord Chancellor in summing up the arguments, mostly of a practical nature, against adoption of the Bill, accepted Lord Dawson's scientific view as "completely reliable".

New Explanation of the Great Glen Fault

THE powerful dislocation which intersects Scotland in a north-east and south-west direction along the line of the Great Glen has usually been interpreted by geologists as a normal fault with a vertical downthrow on its south-eastern side. In an important paper read before the Geological Society of London on February 8, however, Dr. W. Q. Kennedy brought forward new evidence which leads him to believe the fracture as a strike-slip or wrench fault with a true lateral displacement of approximately 65 miles. It belongs, therefore, to the same class as the San Andreas rift of California and, like the latter, presumably extends downward at least to the base of the earth's granitic shell. This conclusion is supported by several independent lines of evidence. (*a*) The Great Glen fault belongs to the same system as the Strathconan, Ericht-Laidon and Loch Tay faults, all of which have proved lateral displacements of up to five miles. (*b*) It possesses characters unlike those of a normal fault but similar to other strike-slip dislocations (for example, singularly smooth, straight outcrop and abnormally wide shatter-belt). (*c*) It displaces the great north–south injection belt of the Moine Series for a distance of at least sixty miles. (*d*) It truncates the Strontian granite, the southern portion of which, according to the detailed structural evidence, is missing. The missing half, however, has now been identified in the Foyers granite, which outcrops on the other side of the fault some sixty-five miles to the north-east and is similarly truncated by the fracture. These two intrusions consist of identical rock-types and agree in all details of internal and external structure. This interpretation clarifies certain obscure features of Scottish geology and serves to explain the southern continuation of the Moine Thrust in Islay. The fault is still active but the main lateral movement appears to have been

accomplished in Upper Devonian or Lower Old Red Sandstone times. The dynamical interpretation of the movement, moreover, indicates that the fault must have resulted from a regional compression which acted in a north and south direction. The fracture is, therefore, unrelated to any Caledonian pressure or tension, but formed as a result of early Hercynian pressure.

British Industries Fair

THE British Industries Fair, 1939, will open on February 20. It is divided into two main sections—one at London and the other at Birmingham; and the London section is again divided into two groups—one at Olympia and the other at Earl's Court. The number of overseas buyers who have intimated their intention to come to the Fair is six hundred more than last year and they are coming from no fewer than 66 countries. Holland heads the list, sending 607 compared with 465 last year. Belgium is second, 293 having accepted as against 245. Eire is sending 269 as against 207; Poland, 164 compared with 72; Czechoslovakia, despite recent happenings, 154 as against 37; Hungary, 110 as against 19; from Denmark there is a slight falling off, 105 compared with 112; and from Switzerland 96 are coming, as against 79 last year. The hardware and heavy industries section of the Fair will be held, as heretofore, at Castle Bromwich, Birmingham. At Earl's Court the main exhibits will be those of the textile and furnishing trades, and also an Empire section. At Olympia the trades exhibited will include chemicals (light and heavy), scientific instruments, photographic and cinematographic apparatus, radio apparatus and plastics, in addition to a large number of other industries, such as glass and leather, usually regarded as belonging to the category of light industries. Among the chemical exhibits, that of Imperial Chemical Industries, Ltd., repeats the practice, introduced by this firm last year, of showing only one major product at a time. Last year the subject was soda; this year it will be ammonia. Exhibits will be shown in six main groups: the use of ammonia in its anhydrous form; as ammonia liquor; as ammonium compounds; oxidized to nitric acid; converted to cyanide; and converted to urea.

As in recent years, the scientific instruments section will form a prominent and notable part of the exhibits at Olympia. The national rearmament programme has naturally involved the production on an enormous scale of the scientific instruments needed for the control of the various major weapons of war—such as range finders, periscopes, gun sights, bomb sights and cameras. The latest type of anti-aircraft searchlight will be shown in action, and forms a central feature of the composite stand of this section. It is perhaps not generally realized that the speeds of modern aircraft are such that the anti-aircraft gun may have to be directed as much as two miles ahead to enable the projectile to hit the target. 'Predictors', which automatically calculate this position, are now in general use by anti-aircraft batteries. The War Office has given permission for an anti-aircraft predictor to be displayed and a staff sergeant will be in attendance to give the public information. A photographic apparatus will be shown, which enables a photographic record to be made of a 500-page book on only 30 ft. of film—an apparatus obviously of great potential use to libraries. Among other apparatus and instruments to be exhibited will be the latest cinematographic projector; a new type of highly efficient loudspeaker of very small dimensions; a projection saccharimeter, which gives an image on the screen showing the percentage of sugar in various foods; and a recent form of dust counter—the 'thermal precipitator'.

Methods in the Study of Man

NUMEROUS questions of general interest, but in their immediate bearing more nearly affecting those concerned with teaching and research in the study of man, were raised by Dr. Henry Balfour in his Frazer Lecture delivered at Liverpool in 1937 and recently issued in pamphlet form ("Spinners and Weavers in Anthropological Research". Oxford: at the Clarendon Press, 1938. Pp. 19). The science of anthropology is a relatively young science; but its progress in recent years has been remarkably rapid. This has been due largely to a vigorous growth of specialization. So much so, indeed, that not only has it brought about a condition which now renders it unwieldy for the individual, but as Dr. Balfour pointed out, there is a real danger that the major problem, the full comprehension of man's nature and potentialities, may be lost sight of, through increasing individual enthusiasm over one or other branch of the general science of anthropology. Dr. Balfour himself was convinced not merely that there is place for both the 'generalist' and the 'specialist', but in fact that there is a real need for their co-operation as a condition of orderly advance in the future development of the science. Metaphorically their relation is expressed in the title of Dr. Balfour's lecture. Taking as an example the methods employed in one of the departments of his own special branch of study, technology, he expounds how in his conception of the relation of the diverse methods of study, the 'spinner', the specialist, provides the threads of surely grounded data from which the weaver, the 'generalist', fashions the fabric of theory. Among the conclusions which follow from this conception to which Dr. Balfour referred, not the least significant is that which develops its bearing on the organization of the curriculum for the anthropological student.

Archæological Interpretation and Modern Analogies

Among other matters upon which Dr. Balfour touched as incidental to the main thesis of his Frazer Lecture, not the least interesting is the interpretation of archæological data in the light of reference to objects of the material culture and to the practices and beliefs of modern and still-surviving peoples of backward culture. He recalled the opportunity for such a comparison, which was lost irretrievably when the Tasmanians, a people still living the life of palæolithic man, were allowed to die out in the last century and themselves became the subjects of the archæo-

logical method of research. Although it is widely appreciated that in the archæological studies of the last generation nothing has contributed more fruitfully to understanding of the culture of the stone age than the interpretation of the palæolithic cave paintings of southern France and Spain by reference to the magical and religious beliefs of modern 'savages', nevertheless many archæologists hesitate to press such analogies. They point to the unquestionable fact that the culture of the modern 'primitive' has not been static over a long period, but has itself been the subject of an evolutionary process, even though they may admit with Dr. Balfour that change has been slow, when no extraneous element has been implicated. Yet instances of the prolonged persistence of unchanged tradition do undoubtedly occur. An interesting illustration bearing on the argument is afforded by Mr. S. Casson's study in *Antiquity* of December last of survivals among ceramic types now current in Cyprus and the islands of the Ægean, belonging to a tradition which extends back not only to medieval times, but even in some instances to the bronze age. He points out how the methods of manufacture, marketing and distribution between the islands and to the mainland still followed at the present day may serve, with their Homeric flavour, to throw light on the obscure field of the early industrial and commercial organization of the eastern Mediterranean, about which so little is known in detail.

Research in Mental Disease at Birmingham

ON February 9, a memorial plaque to the memory of the late Sir Frederick Mott was unveiled by Lady Mott in the Medical School of the University of Birmingham at Edgbaston. The plaque, which is the work of Miss Phyllis Mott, the daughter of Sir Frederick, was the gift of Dr. H. A. Pullar Strecker. Sir Gilbert Barling, in an introductory address, said that the Joint Board for Research in Mental Disease has now found its home in the new Medical School of the University, where it has excellent laboratory accommodation. The laboratory was originally opened at Hollymoor in 1923 by the Minister of Health (the present Prime Minister) with Sir Frederick Mott as honorary director of the Joint Board of Research, and Dr. F. A. Pickworth as chief research officer. It was hoped that the mental hospitals in the surrounding counties would join in the research, and this hope is now fulfilled by Staffordshire, Leicestershire, Worcestershire and Shropshire. Sir Gilbert acknowledged the generous help of Sir Charles Hyde both in 1923 and at the present time. Funds are now available for the appointment of another full-time research officer of high standing to study the influence of viruses and hormones as causes of mental disease, and a surplus is to be used to provide the stipend of a research scholar for three or four years.

Roman Road near East Grinstead

A ROMAN road, which is described as "one of the most perfectly preserved of its type in Britain", has been discovered in a field at Holtye near East Grinstead (*The Times*, February 13). It is part of the old Roman highway which ran from London to Lewes and here crosses a field. The land on which it is situated has been purchased by Mr. I. D. Margary, a Sussex archæologist, for the purpose of investigation and later preservation. At present a stretch of the road, about 85 yards long and varying in width from 15 to 18 ft., has been uncovered. Wheel marks are plainly visible; but the iron-slag surface has rusted together so solidly as to form a mass almost as hard as concrete, and consequently in an excellent state of preservation. In certain places it has been necessary for the workmen to remove soil to a depth of three feet to reach the surface of the road. The remains of vegetation several inches in depth indicate that at one time a forest grew over the road.

Research in Electrical Industries

LORD STAMP, the new president of the British Electrical and Allied Industries Research Association, when addressing members at a luncheon which followed the annual meeting in London on February 10, laid stress on the value of research in industry. He pointed out that the electrical industry takes a leading place in research because it has no real industrial or commercial history apart from the history of research and invention. Most industries grow out of, and often cling to, primitive operations on raw materials to supply age-old needs. Scientific research, if added to them, complicates them; and many think that these additions are a doubtful advantage if they cannot be confined to benefit those who promote them. They think that it makes competition more keen in various branches of the industry and often, as well, creates unnecessarily rapid obsolescence in plants still working. The whole genesis of the electrical industry has been different; it was born out of research and is meeting the created needs of an advanced civilization. Continuous research is its natural sustenance. The work of this Association is an excellent example of co-operation between manufacturers and users; it pools their ideas, thus ensuring that both sides get full benefit from them.

Thermal Power Plants for Emergency Service

A MAJOR interruption of the electric supply in a city of any importance is nowadays attended with disastrous consequences. The provision of some reserve source of power, capable of supplying the vital services at least, is therefore imperative when such failures can occur. The main causes of failures are breakdowns of transmission lines, strikes or enemy bombardment. A paper read by Mr. Hvistendahl on November 10 to the Institution of Electrical Engineers distinguishes between the different classes of service to be furnished by stand-by plants. Descriptions are given of automatic and semi-automatic stand-by plants used in towns in Norway and Sweden. Although unthinkable a few years ago, the bomb-proof emergency service station is now a grim reality. Sandbags provide some protection against fragments of stray shells or bombs, but they are little use against repeated attacks from the air,

and a large steam-power station is an easily located target. This has led to the construction in several countries of the Continent of bomb-proof stand-by power plants for the essential services in towns or districts or for supplying the power requirements of munition factories. These plants are either of the surface or of the underground type. The plan of a station for an output of 10,000 kw. is shown located in a tunnel cut into the face of a cliff. The turbo-set, boiler and tanks containing sufficient fuel for 7–10 days' service, and the auxiliary starting set, are accommodated in a gallery about 150 ft. long and of about the section of a normal double-track railway tunnel. When ground conditions are not favourable to such a disposition, or the danger of flooding exists, a station of the surface type is adopted, with roof and walls of reinforced concrete about 4 ft. thick, having the appearance of a block of dwelling houses or made inconspicuous in some other way.

A Naturalists' Directory

WE have recently received a copy of the thirty-first edition of the "Naturalists' Diary" (Salem, Mass., U.S.A.: The Cassino Press. 3 dollars). It contains the names, addresses and special subjects of professional and amateur naturalists of North and South America, etc. This list will prove very useful to naturalists in the United States, since for that country it seems comprehensive; but in other countries, such as Great Britain, its usefulness is impaired by the sparsity of entries. For example, for the State of New York alone there are about four hundred and fifty entries, while for the whole of Great Britain there are only eleven; for France, six and for Germany, six. The list should prove useful, however, to naturalists outside the United States who wish to get in touch with their American contemporaries. Appended to this directory is a short list of scientific periodicals. While in the compilation of such a list it is naturally essential to be selective, it is difficult to understand what policy was adopted by the compilers, since it is rather inconsistent. Most of the periodicals are American; but even here it is difficult to see why the *Journal of Applied Physics* should be included in a list for naturalists, and the *Botanical Gazette* omitted. Again, among the British journals is included the *Journal of the Chemical Society*, but not the *Aquarist and Pondkeeper* or *Discovery*. Of foreign journals, only *Scientia* and *Helvetica Physica Acta* are mentioned, whereas journals of international appeal to naturalists, such as *Chronica Botanica*, are omitted. The price for a paper-covered book of about 230 pages is high.

Periodicals for Medical and Scientific Libraries

THE selection of periodicals for medical and scientific libraries is discussed by C. C. Barnard, librarian of the London School of Hygiene and Tropical Medicine, in a paper in the *Library Association Record* of November, 1938. Mr. Barnard gives a comparison of results obtained by Gross and Gross' method of arranging periodicals in order of importance as indicated by the frequency of bibliographical reference to them, taking the *Journal of the American Chemical Society* for 1927 instead of the 1926 volume as used by Gross and Gross. Although agreement is satisfactory at the top of the scale, there are considerable variations lower down, and Mr. Barnard points out that, besides the inherent limitations of the method, which does not take account of frequency of publication of the periodicals or of the length of their articles, comparison on the basis of one year's references is too narrow to be trustworthy. Results obtained at the London School of Hygiene and Tropical Medicine for a large number of medical periodicals by marking each volume or part on the table before return to the shelves are tabulated and discussed, particularly as a check upon the personal selection of experts. Mr. Barnard directs attention to the infrequent reference to the earlier volumes of even such periodicals as *Annales de l'Institut Pasteur* and *Zeitschrift für Hygiene*, and suggests that the compilation of similar records by all libraries co-operating in the inter-library loans system might permit recommendations on the basis of a comprehensive survey which would effect appreciable savings in postage and also in time and labour by the redistribution of certain periodicals among the participants.

ASLIB Conference Report

THE report of proceedings of the fifteenth Conference of the Association of Special Libraries and Information Bureaux (price 5*s*.), which has just been issued, contains the text of papers presented at the Conference together with summaries of some of those presented at the joint session with the International Federation for Documentation on the organization of information services. An additional paper from Mr. G. Lightfoot, secretary, Council for Scientific and Industrial Research, Commonwealth of Australia, on the establishment of an information service by that Council is also included, as well as summaries of certain papers contributed to the joint session on 'tools' for library co-operation and reports received from the National Central Library and the British Society for International Bibliography.

Air Raid Precautions in Hospitals

A BOOKLET containing advice on the structural and other precautions that can be taken against air raid risks in hospitals has been issued jointly by the Ministry of Health and the Department of Health for Scotland to all local authorities controlling hospitals and also to voluntary hospitals (London: H.M. Stationery Office. 3*d*. net). Hospital authorities are urged to proceed at once with the precautions recommended, the extent to which they do so depending in some degree on the likelihood of air attack in the area. Measures are described for the adaptation of existing buildings, as well as structural features suggested for new buildings. The Government is prepared to contribute to the cost of these measures under certain conditions.

England - Cape Town Flight

MR. ALEX HENSHAW had made a new record for the round flight between Gravesend and Cape Town when he returned to Gravesend at 1.51 p.m. on February 9. The total journey of nearly 12,000 miles was made in 4 days 10 hours 16 minutes, thus improving by 1 day 6 hours 44 minutes on the previous record set up by Mr. A. E. Clouston and Mrs. Kirby Green. The Percival Mew Gull aeroplane showed no serious signs of damage and the 200-h.p. Gipsy Six engine was still in good condition at the end of the flight. The times for the journey out and that for the return flight, namely, both about thirty-nine hours, are also records.

Vienna Academy of Sciences: Prize Awards

THE following awards have recently been made by the Academy of Sciences in Vienna: Haitinger prize for physics to Dr. H. Haberlandt, for his work on the luminescence of fluorites and other minerals; Rudolf Wegscheider prize for chemistry to Dr. R. Kuhn, for his work on lactoflavine; Fritz Pregl prize for microchemistry to Dr. F. Hecht, for his work on microchemical analysis, particularly of thorium, monazite and uranium minerals; Hansgirg prize for astronomy to Dr. M. Beyer, for his work on the photometry of stars, and in particular for his work on variable stars.

Announcements

THE James Scott Prize (1938) of the Royal Society of Edinburgh was presented to Prof. P. A. M. Dirac, at the ordinary meeting of the Society held on February 6, when he delivered an address entitled "The Relation between Mathematics and Physics".

THE James Alfred Ewing Medal of the Institution of Civil Engineers has been awarded to Prof. A. H. Gibson, professor of engineering in the University of Manchester. This Medal was founded in 1936 in memory of the late Sir Alfred Ewing, and is awarded to a person, whether a member of the Institution or not, for specially meritorious contributions to the science of engineering in the field of research.

PROF. F. G. DONNAN has been elected president of the Association of Scientific Workers, in succession to Sir F. Gowland Hopkins, whose term of office has recently ended.

DR. FABIUS GROSS, lecturer in experimental zoology in the University of Edinburgh, has been elected the first holder of the Jacobsson fellowship for research in the new Oceanografiska Institutet of Göteborg, Sweden. The research is in connexion with the inauguration of a new plankton-well, in which the life-histories of plankton may be studied in conditions resembling as closely as possible those in the sea. The University has granted Dr. Gross leave of absence to cover the period of the investigation.

PROF. ADOLF WINDAUS has been awarded the Pasteur Medal for his lectures in Paris on the investigation of vitamins.

SIXTEEN more names have been added to the memorial erected by the German Röntgen Society in commemoration of those roentgenologists and radiologists who sacrificed their lives to science.

M. BERNARD LYOT, who has been awarded the Gold Medal for 1939 of the Royal Astronomical Society, will deliver the George Darwin Lecture at the ordinary meeting of the Society on May 12. The lecture will be illustrated by a film showing the motion of matter in solar prominences and by photographs of the solar corona in the absence of a total eclipse.

AT a meeting of the Royal Astronomical Society held on February 10, the following officers were elected: *President*, Prof. H. C. Plummer; *Vice-Presidents*, Prof. S. Chapman, Mr. W. M. H. Greaves, Dr. H. Spencer Jones and Prof. F. J. M. Stratton; *Treasurer*, Mr. J. H. Reynolds; *Secretaries*, Prof. H. H. Plaskett and Mr. D. H. Sadler; *Foreign Secretary*, Sir Arthur Eddington.

THE Division for the Social and International Relations of Science of the British Association is holding a meeting at the University of Reading on March 28 to consider "Milk in its Nutritional Aspects". Further information will shortly be obtainable from the Secretary, British Association, Burlington House, Piccadilly, London, W.1.

THE annual general meeting of the Association of Technical Institutions will be held in London on February 24–25. Three discussions will be held, namely, (1) on the Report of the Consultative Committee; (2) on the Report on Libraries in Technical Institutions; (3) on the Report on Psychological Tests. Further information can be obtained from Dr. H. Schofield, Loughborough College, Loughborough, Leicestershire.

THE Minister of Health has approved an order made by Slough Town Council under the Town and Country Planning Act, 1932, for the preservation of Observatory House, Slough, the residence of Sir William Herschel, where he set up his famous 40-ft. telescope, and also of his son, Sir John Herschel.

THE fifth Elihu Root Lecture entitled "Cultural Contacts of Science" delivered by Sir Richard Gregory on December 8, in the Elihu Root Hall of the Carnegie Institution of Washington, extracts from which were printed in NATURE of December 19, p. 1059, has now been issued in book form. The Elihu Root Lectures were founded to deal with the influence of science and research on current thought. Copies may be obtained from the Carnegie Institution of Washington, Washington, D.C.

IT was stated in the report received from the British Museum (Natural History) that the diamond presented by Sir Ernest Oppenheimer to the Museum was the first to be taken from the Kimberley diamond mines (NATURE, Feb. 4, p. 195). We are informed that this is incorrect. The stone came from the Jagersfontein mine in the Orange Free State.

Research Items

Organization of Labour in Ancient Egypt

IT is remarkable that so few records of times taken for ancient enterprise, excepting wars, have been preserved. From one such record, the construction by King Amenophis III of a vast lake of which the site is considered to be a rectangular enclosure near the temple at Medinet Habu, Mr. R. Engelbach and Mr. J. W. Macaldin have endeavoured to arrive at an estimate of the number of workmen employed to have produced this work within the period named (*Bull. de l'Inst. d'Égypte*, **20**; 1938). The rectangular enclosure is in size some 2200 metres by 1000 metres. On four commemorative scarabs known, of which one is only a fragment, it is stated that on the sixteenth day the king and his consort sailed on the lake in the royal barge; but it is pointed out by Breasted that the dimensions of the lake differ from those given on the scarabs. Air photographs, however, suggest that although the length-breadth proportions are different, the variant dimensions can be reconciled. Though the lake is generally described as a pleasure lake for Queen Tyi, this is not mentioned on the scarabs; and it is probable that it was intended to serve as a harbour for the numerous boats which would be required by the new palace built by Amenophis. The possibility whether the lake could have been constructed in the time depends upon the number of diggers who could be put to work simultaneously in the space and efficiently served by carriers of the spoil. The only method feasible would be to divide the area into a number of bays, in each of which it is calculated 184 diggers could work while leaving space for the passage of the carriers. This method of excavating is followed in modern Egypt, and on this basis it is calculated that 184 diggers could excavate a bay in 13·96 days. Taking the distance to the still existing mounds of spoil, the calculation gives 50,968 diggers, 50,968 diggers' mates and 675,326 carriers; total, 777,262 men. If, however, the carrying were reduced to temporarily dumping the soil by the side of the lake for later transport to a greater distance, the carriers might be reduced to 140,716.

North American Birds of Prey

THE most complete account of the life-histories of the birds of any country is that now being published by the U.S. National Museum in its series of *Bulletins*. The series began in 1919 and now with Part 2 of the birds of prey has reached its eleventh volume (*Bulletin*, 170; 1938). This part is as thorough as its predecessors, giving as full an account as possible of the life-history of the best-known American subspecies of each species, and to avoid duplication confining the discussion about other subspecies to distinctive characters, peculiar habits, and range. Some idea of the scope of the treatment may be gathered from the fact that the 482 pages and 92 plates of the volume describe only 28 different species, or reckoning in addition the sub-species 76 different forms in all. The screech owl (*Asio otus*) is the most prolific in racial varieties, with 14 subspecies in addition to the typical form which itself, as Outram Bangs showed in 1930, has a considerable range in the States. The author, Arthur Cleveland Bent, finally, one hopes, gives the lie to the old fable of the communal life of the burrowing owl with the prairie dogs and rattle-snakes of the western plains. He points out that so comprehensive a work can only be the result of co-operation, and that if any reader fails to find in the volumes anything that he knows about birds, he can blame himself for not having sent in the information. Thus is the critic disarmed.

Nicotine and Bees

IN the *Bee World* of January 1939, a short but interesting account is given of the work of F. K. Böttcher, published in *Die Gartenbauwissenschaft* (**12**, 2; 1938) on the effect of nicotine on bees. It appears that this substance repels bees, and that it is difficult to induce them to take it. When nicotine was added to the drinking water of the bees at any strength over 0·05 per cent, it repelled these insects so much that there was no fear of their imbibing much of it. When a field of mustard was dusted with nicotine in the usual way (2·5 per cent) most forager bees were driven away; only a few became poisoned. Neither dusting nor spraying caused any damage of practical importance to the colonies. It can be concluded, therefore, that when nicotine is used as a dust or as a spray in concentrations of 0·15–2·5 per cent, no damage of practical importance to bees results. This work, if confirmed, is important to bee-keepers and fruit-growers in view of the repeated warnings given about the damage caused by nicotine applications to fruit trees when the blossoms are visited by bees.

Induced Polyploidy by Treatment with Colchicine

A REPORT was presented by A. J. T. Mendes, of the Instituto Agronomico do E. de S. Paulo Campinas, Brazil, at the first South American Botanical Meeting held at Rio de Janeiro, last October, on the preliminary results obtained by treatment of seed and plants of coffee, cotton and tobacco with colchicine. The embryo of the coffee seed is surrounded by a large amount of nutritive matter; the immersion of seeds in solutions as strong as 0·6 per cent for a period of 35 days did not produce changes other than a delayed germination. But a 0·15 per cent solution acting during 4 days was highly effective when the seeds were treated only 35 days after they had been sown in an ordinary seed bed: the plants originating from these seeds were characterized by a stunted growth of the hypocotyl and by the late development of the plumule. Counts of chromosomes in root tips of these plants revealed $2n = 88$, while the normal plants had $2n = 44$. Seed of *Gossypium hirsutum* ($2n = 52$) and *G. herbaceum* ($2n = 26$) treated for 16 hours by a 0·15 per cent colchicine solution produced thick-leaved plants with short internodes. In root tips, $2n = 104$ and $2n = 52$ were determined respectively. Several treatments have been tried on *Nicotiana tabacum* and other species and species hybrids of *Nicotiana*; plants have been obtained which by their external appearance seem to be polyploid. These experiments are still incomplete.

Pollen Tubes of Cotton

A STUDY of various problems connected with the growth of pollen tubes in cotton has been made by N. K. Iyengar (*J. Genetics*, **37**, No. 1). The method found most satisfactory was by direct observation of the pollen tubes in the pistil after suitable treatment. There is a central conducting tissue in the style, and the tubes run for some distance over the placenta before reaching a micropyle. The pollen grains germinate promptly on the stigma, putting forth several tubes which form some branches in the style. Callose plugs are also described. The tetraploid cottons generally have larger pollen grains and wider pollen tubes than the diploids. When the two are present on the same stigma they both germinate, but the self pollen takes part in fertilization. Two to four pollen tubes sometimes enter one micropyle; but there is no evidence that more than one takes part in fertilization. By examining the ovary 25½ hours after pollination, evidence was obtained regarding the order of entry of the pollen tubes into different ovules of the flower. It was found that the first ovules in a locule to receive pollen need not necessarily be the ones nearest the stigma.

Synthesis of Polyploid Types by Hybridization

MÜNTZING'S experiments on hybrid incompatibility and the origin of polyploids has brought out the fact that zygotes tend to be more viable if produced by union of gametes with approximately the same chromosome number. M. Skalińska (*Bull. Int. de l'Acad. Polonaise des Sci. et Lett.*, B, Sci. Nat. (1) 1938) in carrying out breeding experiments with hyperdiploid *Aquilegia* plants with 15 ($2n + 1$) and 16 ($2n + 2$) chromosomes, obtained a proportion of giant pollen grains by formation at meiosis of restitution nuclei, fusion of spindles in meiosis II or unipolar spindle fusion, giving diploid and extra chromosome types of pollen. It was concluded that such giant grains would compete favourably with haploid or hyperhaploid grains in tetraploid tissues. The results of such crosses fully confirmed Müntzing's observations as pollination of the tetraploid with pollen containing a proportion of giant grains produced, in addition to one triploid ($21 = 3n$) and one hypertriploid ($23 = 3n + 2$), tetraploid (28) and hypertetraploid plants with 29 ($4n + 1$) and 30 ($4n + 2$) chromosomes.

Regional Coupling of Earthquake Shocks

ON the basis of a study of the earthquakes with epicentres in Iceland, in Austria, in the Philippine Islands and in Norway, E. Tams is of the opinion that although when earthquakes are studied individually there may appear to be no connexion between them, yet studied regionally there may be some underlying geotectonic cause for the earthquakes in any one region ("Zur Frage der regionalen Verkoppelung von Erdbeben", *Z. Geophys. Jahrg.*, **14**, Heft 7–8; 1938). This regional movement may cover a very large area, and may also be very extensive in time, so that individual earthquakes in the region may appear to be entirely independent of each other. As regards Norwegian shocks, there now appears to be a tendency for them to be less severe and less frequent, probably indicating a slackening of the recovery movement of Norway from its load of ice during the Pleistocene Ice Age. Considering the widely separated regions, there appears to be no correlation between their shock-frequency curves; but if we assume a hypothetical endogenous cause for all these regional tectonic movements, then this cause must be the connecting link between them and hence between the several earthquake shocks.

Heats of Combustion of Diamond and Graphite, etc.

Three recent papers (*J. Res. Nat. Bur. Stand.*, **21**, 457, 475, 491; 1938) by P. H. Dewey, D. R. Harper, R. S. Jessup and F. D. Rossini deal with anthracite cokes, natural and artificial graphites and diamonds from the point of view of heats of combustion and stability, and provide important new data in this interesting field of thermochemistry. In agreement with previous results, it is found that the heat of combustion of 'amorphous' carbon is higher than that of diamond, and that of diamond is higher than that of graphite. The results are expressed in international kilojoules per mol (12·01 gm.) of carbon to form CO_2 at 25° and 1 atm. pressure without the production of external work. The results do not indicate the existence of different forms of graphite and diamond. The values are: graphite, 393·388 int. k.j. (94,030 gm. cal.); diamond, 395·287 int. k.j. (94,484 gm. cal.); 'amorphous' carbon, 403·03 int. k.j. (extropolated to zero hydrogen content). The papers contain thermodynamic discussions of the stability of the forms of carbon and deal critically with a large amount of numerical data.

Accuracy of Meteor Data

IN a previous paper (*J. Brit. Astro. Assoc.*, **48**, 9; July 1938), J. G. Porter discussed the errors in the true paths of doubly observed meteors, and in a recent paper (*J. Brit. Astro. Assoc.*, **49**, 3; Jan. 1939) he deals with the accuracy of radiants. Porter utilized thirty-five doubly observed Perseids from 1934 until 1937, and his procedure consisted in determining the true radiant from the elements of Comet 1862 iii which is responsible for the Perseid shower. As the Perseids persist for an unusually long time, computations of radiants were made from July 29 until August 16, and these were compared with the radiants deduced from doubly observed meteors. A very full analysis of the results is made, and, although only thirty-five doubly observed meteors were available, it is highly probable that the deductions are a safe criterion regarding observational errors in general, or at least for the British observers. The probable error of the radiants is ±2·4°, and this is very small compared with the results found for American observers. Öpik accepted a probable error of ±8° for the Arizona Meteor Expedition observers, and others have quoted even higher figures. Various other deductions were made from the analysis in this and the previous paper, amongst which the following may be noticed: For the deviations of the flight-directions the probable error was ±2·54°, and errors of half a magnitude were found in the mean *zenithal magnitude*, the reduction of apparent to zenithal magnitude being made by a simple formula suggested in the earlier paper. Velocity errors depended upon the time of flight; the smaller this was, the greater the errors. The mean deviations in heights seem remarkably small, considering the difficulties of accurate observations. From a list of 309 available meteors, these mean deviations were only 3·6 km. at the beginning and 2·8 km. at the end of the path—excellent testimony to the accuracy of the observations.

Photoperiodism in the Plant Kingdom

By Dr. R. O. Whyte and M. A. Oljhovikov, Imperial Bureau of Pastures and Forage Crops, Aberystwyth

THE announcement of the formative effect of such a dilute factor as relative length of day and night, introduced by Garner and Allard[1] as photoperiodism, has become the subject for many studies by ecologists and physiologists. Although different investigators hold divergent and conflicting views as to the exact class even of forms and races within a species, not to speak of the class of distinct species, there seems to be a general consensus of opinion as to the existence in the plant kingdom of three categories or groups of plants in respect of the so-called photoperiodic response or photoperiodic adaptation. The existence, however, of the very large neutral group which possesses no clearly defined critical photoperiod[2] might almost alone indicate the invalidity of that classification; but the fundamental fallacy lies in the study of photoperiodism as an isolated episode, without any reference to the preceding (including seed ripening) and subsequent periods in the life-history of the plants.

Eghis[3] found, however, that short-day plants would flower quickly in long photoperiods if previously grown for 10–20 days in short photoperiods. This became known as the photoperiodic after-effect (Maximov), or photoperiodic induction (Ljubimenko), as the photoperiods, while causing no immediate morphological changes, were assumed to induce certain chemical readjustments, resulting in early flowering. While this finding may have improved the experimental technique, it failed to contribute anything substantially new to the principles of photoperiodism.

The announcement of the principles of phasic development (vernalization) by Lysenko[4] and his associates gave a quite unexpected approach to photoperiodism; neither short-day nor long-day plants, it was claimed, require photoperiods to attain flowering, and the contrasted behaviour of these plants was interpreted as implying that long-day plants at one of the developmental stages (photo-phase) require daylight in excess of the critical photoperiod, while short-day plants at that stage require darkness or at least a long night (a day shorter than the critical photoperiod). It was alleged that, on completion of the photo-phase, long-day plants would attain flowering in short days (below the critical photoperiod), and short-day plants in long days exceeding the critical photoperiod; these claims which, with certain reservations, were anticipated by Garner and Allard (1922) and Wanser[5], were confirmed in many later experiments.

Razumov[6] also interpreted the effect of photoperiods as a retardative effect of light on the initiation and progress of the photo-phase in short-day plants and as an inductive effect on the photo-phase in long-day plants. The causal effect of light varied with the intensity of illumination, and it was concluded that the difference between long- and short-day plants could be interpreted in terms of an innate requirement for a definite intensity of light; as this intensity varied with the geographical origin of forms of either group and within each group, and ecotypes could be selected which might be induced to flower under the same intensity of light (namely, northern ecotypes of short-day plants and southern ecotypes of long-day plants), it was concluded that there is no clear-cut demarcation between these groups and that they constitute a single series of forms in which the inductive intensity of light progressively decreases from very high to very low.

This hypothesis overlooked the conspicuous difference between these plants[7], namely, long-day (high intensity) plants require high intensity (light) and tolerate low intensity (darkness) if not below a critical (low) limit, while short-day (low intensity) plants require low intensity (darkness) and tolerate high intensity (light) if not above a critical (high) limit. It was concluded that, if these plants are to be contrasted in respect of their relation to length of day at this developmental stage, they would appear to form ecologically different groups.

Further investigations on phasic development in wheat[8,9] showed that vernalized plants (that is, those which had completed the thermo-phase at which they do not respond to photoperiods) failed to respond to prolongation of day during the first 8–10, or even 15–18 days in winter forms, after planting, the longer day having a retardative effect, stronger in winter (late) forms and weaker in spring (early) forms; later they behaved in the usual way. It was concluded that this impotency of young plantules was due to the existence of a stage at which both spring and winter wheats require high temperature (in contrast to the thermo-phase) and darkness (in contrast to the photo-phase). Subsequent investigations confirmed this supposition[10] and seem to explain the discrepancy of opinions regarding the effect of photoperiods on the progress of the thermo-phase in spring and winter wheats and other cereals[7].

Kostjučenko and Zarubaĭlo[11] and later Gregory and Purvis[12] showed that, if ripening seed of winter cereals had experienced low temperature for an adequate period with a diurnal alternation of high and low temperature not below a certain thermo-period[7], the resulting plants would attain earing when grown continuously at high temperatures. As vernalization of this seed had no effect on time of earing, it was concluded that, under certain conditions, such as those prevailing in a northern summer, this stage can be completed during seed ripening. The partial completion during seed ripening of that part of the development which plants usually undergo after sowing (the vegetative period) has been demonstrated by Pobedimova[14] with *Cyclamen* and observed, according to Kostjučenko and Zarubaĭlo[13], in other plants such as barley (Razumov), lupins (Fedotov), peas, cabbages and beets (at the Polar Station, Hibiny).

This led to the conclusion[7] that, if in winter (late) forms this phase can be completed in special circumstances during seed ripening, then in other forms, particularly those requiring relatively high temperature (spring cereals and the short-day thermophytes), that phase may be fully or partially completed during seed ripening each year. In any event it may be said with certainty that the possibility of completion of the thermo-phase is greater in short-day thermophytes (millet, cotton) than in long-day

cereals, and in spring forms as compared with winter forms. It seems safe to assume that the shortness of the thermo-phase in short-day plants may be due merely to the full or partial completion of that phase during seed ripening; hence their vegetative period begins either with the end of the thermo-phase or even with the subsequent phase, at which they require darkness and high temperature. In winter (late) cereals requiring low temperature, the completion of the thermo-phase during seed ripening is of less frequent occurrence and regularity than in spring (early) cereals, which require relatively higher temperature at that phase; in the latter the subsequent phase, requiring high temperature and darkness, may also be fully or partially completed, with the result that the vegetative period begins either from the end of the 'dark phase' or even from the 'light phase', thus affecting the relation of plants to day length.

There is ample evidence that the so-called short-day plants (in Garner's terminology) could be described as 'short-day → long-day' plants[2] in respect of their photoperiods; that is, a 'dark phase' is followed by a 'light phase'. Referring to Wanser's assumption of the existence of a 'short photoperiod' requirement preceding a 'long photoperiod' requirement in long-day wheats and the discovery of the 'dark phase' in wheats, the long-day plants could also be described in respect of their photoperiods as 'short-day → long-day'. Therefore, the sequence of ecological phases during that particular section of the life of long- and short-day plants may be described thus:

Long-day plants:
. . → *thermo-phase* → *dark phase* → *light phase* → . .
Short-day plants:
. . → *thermo-phase* → *dark phase* → *light phase* → . .

that is, there is no distinction in principle between these groups of plants, as claimed on the basis of the photoperiodic classification (Garner and Allard, Eghis), or as interpreted by Lysenko and his associates and Razumov, the difference between these photoperiodic groups being of the same class as that within the groups, or even species; there is a strict parallelism in the nature and sequence of the ecological phases, from which a parallelism in the physiological phases can be assumed. The conflict of opinions in ecological and physiological studies is chiefly due to the fact that short-day and long-day plants have been compared at different ecologo-physiological phases, namely, the 'dark phase' of short-day plants has been contrasted with the 'light phase' of long-day plants.

The length of these ecologo-physiological phases and the cardinal points of the environmental factors concerned vary with the geographical origin of forms and races, and there are grounds for assuming that the 'dark phase' becomes shortened as the native country is farther removed from the tropics, while the 'light phase' is prolonged in the same direction. Tropical races and polar races may be conspicuous in their relation to day-length, that is, the relative length of the 'dark' and 'light' phases, but they are, nevertheless, merely extreme variants of the same series, and no clear-cut demarcation in this respect should be made in the plant kingdom.

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Fundamental Principles and Method of the Mathematical Sciences

THE programme of scientific activity submitted by the International Institute of Intellectual Co-operation, Paris, to the International Committee on Intellectual Co-operation at its plenary meeting in July last contained a suggestion that a study meeting on "The Fundamental Principles and Method of the Mathematical Sciences" might usefully be convened. This is the first time that the Institute has organized a study committee to discuss a mathematical subject. The scientific meetings held so far had been devoted to biological questions (study and research on phytohormones), physico-chemical questions (physico-chemical methods of measuring the molecular and atomic weights of gases), and physical questions (new theories of physics). The programme already approved by the Committee on Intellectual Co-operation provides for the organization of meetings in the spheres of mathematics (fundamental principles and method of the mathematical sciences, and applications of probability calculations), physics (magnetism, and the philosophical consequences of new theories in physics), and biology (ionizing radiation measurements, and genetic and cytological nomenclature and terminology).

The Committee on Intellectual Co-operation entrusted the carrying out of this programme to the Institute, which, after having received an invitation from the Technical High School in Zurich, got into touch with Prof. F. Gonseth for the technical organization of the proposed meeting on "The Fundamental Principles and Method of the Mathematical Sciences".

This study meeting was held at Zurich on December 6–9, 1938, under the honorary chairmanship of Prof. Rohn, president of the Council of the School. The following took part in the discussions: Profs. Barzin, Bernays, Burckhardt, Dürr, Feys, Finsler, Franel, Fréchet, Fueter, Güt, Hopf, Jørgensen, von Kerekjarto, Kollros, Lebesgue, Łukasiewicz, Mazurkiewitz, Pfluger, Plancherel, Polya, Saxer, Sierpinski, Skolem, Speiser, Stiefel, Völlm, Wavre, Walter, and Dr. Destouches.

At the opening meeting, which was held in the Great Hall of the School, Profs. Rohn and Bäschlin, the president and rector of the School respectively, and Howald, rector of the University of Zurich, delivered

addresses stressing the importance of the meeting. Prof. Gonseth then introduced and explained the subject to be discussed.

At the meetings the following six papers were discussed: "The Significance of the Skolem-Löwenhein Theorem" (Prof. Th. Skolem); "General Analysis of the Question of Fundamentals" (Prof. M. Fréchet); "Logic and the Question of Fundamentals" (Prof. J. Łukasiewicz); "Controversies Regarding the Theory of 'Ensembles' and the Question of Fundamentals" (Prof. H. Lebesgue); "The Role of the Axiom of Choice, and the Hypothesis of Continuity in Mathematics" (Prof. W. Sierpinski); "The Present Position in regard to Hilbertism" (Prof. Bernays).

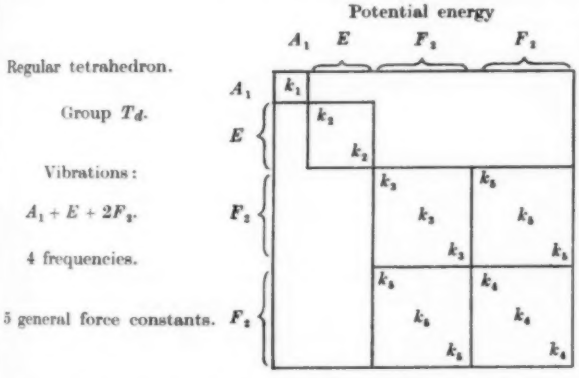
At the end of the meeting Prof. Gonseth summed up the general conclusions to be drawn from the discussions, and expressed his thanks to the Institute of Intellectual Co-operation for its help and collaboration.

The texts of the various papers submitted and an account of the discussions will appear in the fourth volume of the new Scientific Series being published by the Institute.

Molecular Structure

A DISCUSSION on molecular structure was held by the London Mathematical Society on January 19 in the lecture room of the Royal Astronomical Society, the president, Prof. E. A. Milne, being in the chair. The discussion was opened by Dr. W. G. Penney; Dr. H. A. Jahn, Dr. C. A. Coulson and Mr. G. J. Kynch made further contributions, and Prof. J. E. Lennard-Jones summarized the discussion.

Dr. W. G. Penney (Imperial College, London) said that the nuclei of a polyatomic molecule in its most stable state are practically at rest and that the electrons move about in a highly complicated, but regular, way. If the nuclei are slightly disturbed, they vibrate, and their motion can be described in terms of a number of normal modes. Such vibrations can be detected in the infra-red spectrum.



Let $E(x_1, x_2 \ldots)$ be the least energy required to separate a molecule into electrons and nuclei, when the nuclei are stationary at $x_1, x_2 \ldots$. Then, in principle, $E(x_1, x_2 \ldots)$ may be found as the eigen values of the Schrödinger differential equation

$$(H - E)\,\psi = 0 \qquad (1)$$

The energy of formation of the molecule from atoms is

$$W(x_1, x_2 \ldots) = E(x_1, x_2 \ldots) - \Sigma E_a,$$

where ΣE_a is the sum of the energies of formation of the separate atoms from nuclei and electrons. The equations for the E_a are similar to (1). Since W is very small compared with ΣE_a, it is possible to calculate W by perturbation methods. Thus, ψ is expanded in terms of the ψ_a, the Schrödinger functions of the separate atoms. Substituting this in (1), leads to

$$[H^1 - W(x_1, x_2 \ldots)]\ \Sigma \alpha_a \psi_a = 0.$$

Multiplying by the ψ_a in succession, and integrating over the configurational space, leads to a set of equations in the α_a. Eliminating the α_a gives a determinantal equation for $W(x_1, x_2 \ldots)$. Minimizing with respect to $x_1, x_2 \ldots$ gives the equilibrium configuration and the heat of formation; expanding about the minimal configuration leads to the frequencies of the normal modes.

Detailed considerations of the function $W(x_1, x_2 \ldots)$ show, for example, that if four monovalent atoms are combined with a carbon atom, they are distributed around the carbon atom in the directions of the corners of a regular tetrahedron. If the carbon atom is linked directly to only three atoms, so that one of the bonds is double, the system is co-planar. When the carbon atom is linked to only two atoms, so that both bonds are double, or one is triple and the other single, the system is linear.

Little progress has been made in calculating the energies of formation and the vibration frequencies of molecules in excited states, and the description of their absorption spectra is therefore at present only qualitative. A similar, but simpler, problem is that of interpreting the absorption spectra of rare earth crystals. The spectrum is that of an inner group of electrons of the metal ion, and the energy levels are very near those of the free ion.

Dr. H. A. Jahn (Davy Faraday Laboratory, Royal Institution) discussed the vibrational potential energy constants of polyatomic molecules. He showed how, starting from a given equilibrium configuration of a polyatomic molecule and making use of the invariance of the vibrational potential energy with respect to all the operations of the group of symmetry of the equilibrium configuration, the most general form of the elastic potential can be determined.

Mathematically, the invariance of the vibrational potential energy is equivalent to the fact that the matrix of its coefficients must commute with all those matrices which show how the normal displacements transform under the symmetry operations of

the group. Consequently, by choosing a complete set of vibrational symmetry co-ordinates which transform according to irreducible representations of the group of symmetry, there may be obtained at once, by application of Schur's Lemma, the most general form of the matrix of the potential energy.

This was illustrated by the example of the methane molecule.

Thus, if the methane molecule is a regular tetrahedron, the potential energy has five general force constants and the molecule has four different vibrational frequencies. Similarly, if the molecule has the form of a square pyramid, the group is C_{4v}, the vibrations are $2A_1 + B_1 + 2B_2 + 2E_1$, there are seven different frequencies and ten general force constants. Experimentally four frequencies are found, and the molecule has the form of a regular tetrahedron.

Dr. C. A. Coulson (University College, Dundee) discussed the theory of the carbon-carbon linkages in some simple polyenes and aromatic molecules. Certain hydrocarbons can be adequately described by a single structural formula. Examples are ethane, where the linkage is a single bond, ethylene, where the linkage is a double bond, and acetylene, where the linkage is a triple bond. Other molecules, such as benzene, naphthalene and butadiene, are more complex, and in these cases the linkages must be considered to be of fractional order. General methods of calculating the orders of these linkages have been discovered. They evaluate the energy of a linkage by the approximation of molecular orbitals or of electron pairs, in terms of a single parameter which measures the difference of energy of the single and double bonds. Linear interpolation then gives the order.

From the experimental values of certain physical constants of the single, double and triple bonds, empirical curves may be constructed. These may be used to predict values for the linkages of intermediate order. Thus, the benzene linkage is of order 1·65, and the internuclear distance should be 1·39 A., in exact agreement with direct observation. Similarly, in naphthalene, there should be four types of linkage. Their orders, beginning at the central link and working outwards, are 1·52, 1·56, 1·76, 1·60. The corresponding lengths are 1·42, 1·40, 1·38, 1·40 A.

Mr. G. J. Kynch (Imperial College, London) discussed the relations between the magnetic properties, specific heat and absorption spectra of rare earth crystals. The deviations of the principal and mean susceptibilities from Curie's law, χT = constant, are caused by an electric crystalline field which perturbs the magnetic ion. Calculations of the magnetic susceptibilities involve the determination of the lowest energy levels of the magnetic ion. These can be compared with those obtained from the measurements of the absorption spectra and the specific heat. Previously, it was thought that a fourth order cubic field would correlate all the data. This no longer seems possible, because of the considerable magnetic anisotropy of the crystals. A new interpretation of the levels found spectroscopically must be sought.

The British Rhætic Flora

PROF. T. M. HARRIS, with experience of the Greenland Rhætic flora behind him, has now studied the British Rhætic beds and, with the application of new methods, described with considerable detail some of the few plants from these rocks (The British Rhætic Flora, British Museum, 1938.) The main outcrop of Rhætic rocks extends from Dorset to north Yorkshire, and it is from these alone that plant remains have been obtained, though smaller outcrops also occur in Wales, Northern Ireland and Scotland. The conception of the Rhætic formation is that of a shallow sea, dotted with islands, and in this, slight changes in level isolated lagoons, which would soon become brackish or freshwater lakes. It is probably in such lakes that the plants grew. The plant-containing beds occur as strata between those containing fish and other marine remains, suggesting temporary incursions of the sea into the lagoon region. The Bristol locality seems to have supplied most of the specimens.

A new method of examination of surface features by reflected light on specimens moistened with paraffin oil has contributed materially to the success of the investigation. The usual methods of rock sections and cellulose nitrate films have also been used; but are difficult with this material.

A common plant is the alga *Botryococcus braunii*, recognizable as colonies, terra-cotta in colour and with characteristic resistance to $HNO_3 + KClO_3$. It is probable that this fossil is the same plant which has been described under various names from Ordovician, Carboniferous, Permian, Rhætic, Jurassic and other rocks up to the present day.

Another alga has close resemblance to *Cosmarium*; but owing to failure to recognize sculpturing of the wall, it is provisionally distinguished as *Stenizys cosmarioides*.

Perhaps the most interesting plant and one described in amazing detail is *Naiadita lanceolata*, an undoubted bryophyte. Earlier records of Bryophyta are very scanty and only allow the statement that liverworts, probably belonging to the Jungermanniales, extend back to the Carboniferous, whilst records of mosses are more doubtful.

Naiadota is now described with details of stem and leaf form and structure, rhizoids, gemmæ (free and possibly in gemmæ cups, and development of new plantules from gemmæ), archegonia, sporophytes, perianth and spores. The plant is thus sufficiently known to compare with present-day genera. The radial construction and spiral phyllotaxis (3/8) are moss-like features; but the majority of the characters place it in the Hepaticæ, and provisionally as nearest to the Riellaceæ of the Sphærocarpales.

Prof. Harris discusses the conceptions of evolutionary trend in Bryophyta and regards *Naiadita* as supporting rather the view of a reduction series than an up-grade series.

One other plant, *Hepaticites solenotus*, appears to be a hepatic resembling *Aneura*.

Certain other fossils, previously described as Rhætic, seem more correctly to be Liassic.

Training Teachers of Rural Science

IN 1937 the University of Reading Education Department, under the direction of Prof. H. C. Barnard, decided to pay special attention to training teachers for posts in rural senior, central and secondary schools. Three main considerations seemed to make this undertaking a desirable feature of the training course: (1) there was likely to be a considerable and increasing demand for teachers who could teach science with full reference to the rural environment; (2) the University of Reading has a well-organized faculty of agriculture and horticulture; (3) there are in the surrounding countryside several schools which make a speciality of teaching rural subjects.

In instituting the course at Reading, the principle was adopted that it is undesirable to train teachers so narrowly in one aspect of education that they are partially unfitted to see any other aspect. The course in the teaching of rural science was therefore made one of a number of optional subjects, and at present it includes: (*a*) a series of lectures on general aspects of rural education; (*b*) occasional lectures by teachers and others actively engaged in rural education; (*c*) visits to rural schools; (*d*) teaching practice in rural schools; (*e*) practical instruction in horticulture and handicrafts.

The lectures deal with such topics as: the meaning of rural education; comparison of rural and urban schools; Hadow and Spens reorganization in country areas and their implications; the approach to knowledge through practical activities, for example, how the garden can become the centre of a curriculum which differs from the 'normal' only in the principles on which it is devised and the way in which it is developed; the value and the conduct of school expeditions to farms, etc., and the aims, staffing, equipment and finance of gardening, livestock keeping and handicrafts. Special lectures have been given by the head master of a secondary school with a strong 'agricultural bias', by one of His Majesty's inspectors of schools who specializes in rural science and by a horticultural organizer to a county council.

Visits to rural schools, when students have been well prepared in what to look for, have proved to be very valuable, and teaching practice in rural schools has been arranged.

Students receive practical instruction in horticulture at the University Horticultural Station. Their work includes preparation of ground, planting, propagation, pruning, crop rotation, managing a small greenhouse or a frame, grafting, etc. In handicrafts, students are encouraged to make apparatus useful for rural activities, such as model greenhouses, cold frames, etc. A short course in metal-work is being developed, in which students may make such things as gate latches, simple agricultural tools, etc.

The course, as at present constituted, is in its infancy, and is in no way static. Some developments which are contemplated are: contact with a senior school within easy distance of the University; a 'model' garden; instruction in livestock keeping; visits to the University farm; and lectures by farmers.

This then is one way in which Reading is trying to help to forge the rather weak link between education and agriculture.

Students of the University of Reading who have graduated in science or agriculture or horticulture, and who have afterwards spent a year in preparation for the education diploma, including the course on teaching rural science, should be well fitted to teach in a rural school of any type. The University Department of Education already conducts, at the request of the Ministry of Agriculture, a fortnight's course in the "Technique of Teaching" for those who hold posts on the agricultural staff of a county authority or similar positions.

Wave-Action and Shore-Lines

AN article by Mr. W. V. Lewis on the "Evolution of Shore-line Curves" (*Proc. Geol. Ass.*, **49**, Pt. 2; 1938) is a valuable contribution to a well-worn subject. The author's position is fundamentally that of Sir Henry de la Beche, founder of the Geological Survey, who a hundred years ago stressed the importance both of the longshore drift of material by prevalent waves and the independent action of storm or dominant waves in piling up embankments of detritus in the direction of the greatest force, sometimes at right angles to the shore. In later years opinions changed, and explanation of the evolution of coastal outline was purely on the action of longshore and eddy currents. Latterly, however, there has been a revival of the wave-action hypothesis due largely to the findings of the Royal Commission on Coast Erosion and Afforestation and the work of Steers, Johnson, and others. Mr. Lewis proceeds to examine in detail various sections of coastline in Britain on the Moray Firth, Cardigan Bay, Bristol Channel, Isle of Purbeck and Chesil Bank, and suggests that shore curves, far from being explicable only by reference to longshore currents, yield in certain cases readily to analysis in terms of the direction of approach of both dominant and prevalent waves, especially the former.

The case of Weymouth Bay and Chesil Bank is of particular interest. It appears that breakwaters in connexion with the Portland Harbour works have caused a modification in the direction of wave approach, with the result that shingle which used to be driven north from Weymouth is now accumulating in front of the town. This means that the bay has swung slightly round so as to face a more easterly direction. As regards the Chesil Bank, it is pointed out that along its sixteen miles from Chesilton to West Bay we have one of the most perfect examples in the British Isles of a shore moulded into line with both dominant and prevalent waves. This gives stability to the curve of the Beach, which exactly faces the direction of open water just clear of Start Point and Ushant into the Atlantic. The grading of the shingle, which increases steadily in size from West Bay to Chesilton, is held to indicate that there is now no permanent drift of material in either direction. In any case the Beach could not have been formed by simple longshore drift, as this would have first filled up the narrow backwater behind.

Science News a Century Ago

Fox Talbot's Photogenic Drawing

AT a meeting of the Royal Society on February 21, 1839, further information on photogenic drawing was given in a letter written by Fox Talbot to S. H. Christie, the secretary, dealing with the preparation of the paper and the means of fixing the design. Having chosen a paper of good firm quality, and smooth surface, said Fox Talbot, it was dipped in a weak solution of common salt and wiped dry. One side was then treated with a solution of nitrate of silver. By alternately washing the paper with salt and silver and drying it in between times, the sensitivity of the paper was increased. With regard to the fixing of the images, the author said, that having tried ammonia and several other reagents, the first which gave him a successful result was potassium iodide, much diluted with water. On a photogenic drawing washed over with this liquid an iodide of silver was formed absolutely unalterably by sunshine.

Lighthouses on Sandbanks

IN the February 1839 issue of the *Civil Engineer and Architect's Journal*, was an article on the "Construction of Lighthouses on Sands" by the use of the patent screw piles or screw moorings of Alexander Mitchell. On July 4, 1833, Mitchell had secured a patent (No. 6446) for a dock to facilitate the repairing or building of ships, and in this patent he described caissons held in position by means of piles fitted with broad metal screws or worms. Screws could be fitted also to mooring chains. "It having been brought to the notice of the Corporation of the Trinity House," said the *Architect's Journal*, "that the invention might be utilised for establishing lighthouses on sands, they directed an experiment be made by their engineer James Walker. The spot selected for the experiment was the Maplin Sand twenty miles below the Nore, in the mouth of the Thames." Eight screw piles were driven into the sand forming an octagon 40 ft. in diameter, with one in the centre. The piles were wrought iron tubes of 5 in. diameter, 26 ft. long, and each of them was fitted with a screw 4 ft. in diameter. They were driven into the sand 22 ft. by men working on a raft. Afterwards the tops of the piles were braced together to support the lighthouse structure. In 1839–40 a similar lighthouse was built on a submerged sandbank in the entrance to Morecambe Bay.

Earthquake in Leicestershire

THE issue of the *Gentleman's Magazine* for February 1839 contains the following information: "Dec. 23. About four in the afternoon a smart shock of an earthquake was felt at Woodhouse Eaves in Charnwood Forest, Leicestershire. It was preceded by a loud rumbling noise, as of a wagon on the adjoining road, and the shock was sensibly felt by the numerous congregation then assembled in the new church at Woodhouse Eaves; the vibration was so strong as to loosen pieces of mortar from the roof, which several persons heard falling down the slates to the ground. It appears to have been in the direction from the south-west to the north-east or east, from which former point the wind then blew. . . . It is remarkable that an earthquake was felt at Naples about the same time. It is well known to geologists that an anticlinal line of strata is in Charnwood Forest."

University Events

BIRMINGHAM.—The pro-chancellor (Mr. Walter Barrow) and the deputy pro-chancellor (Alderman John Henry Lloyd) have recently resigned their posts. Mr. Edmund Phipson Beale is to be nominated as pro-chancellor. Mr. Beale has been on the University Council since 1923 and became treasurer in 1930. He is a son of the first vice-chancellor, Mr. Charles Gabriel Beale, who was appointed when the University was founded. (The title 'vice-chancellor' was, some years ago, replaced by that of 'pro-chancellor', the former having devolved upon the officer originally called 'principal'.) Alderman Lloyd will still remain on the Council as a representative of the City Council.

CAMBRIDGE.—The Jacksonian professorship of natural philosophy became vacant at the end of January on the resignation of Prof. E. V. Appleton, St. John's College, who has been appointed secretary of the Department of Scientific and Industrial Research. It is recommended that candidature at the next election be limited to candidates whose work is connected with atomic physics. It is further proposed that the Jacksonian professor's duties of residence and lecturing shall no longer be specially prescribed.

Prof. P. M. S. Blackett, Langworthy professor of physics in the University of Manchester, has been appointed Scott Lecturer for the year 1939–40.

SHEFFIELD.—Prof. B. H. Bentley, formerly professor of botany in the University, has been appointed emeritus professor.

Dr. S. Glasstone has resigned his post of lecturer in physical chemistry.

Societies and Academies

Paris

Academy of Sciences (*C.R.*, 208, 237–312, Jan. 25, 1939).

A. GUILLIERMOND and R. GAUTHERET: Effect of *p*H on the vital staining of yeasts. Absorption of Neutral Red, Cresyl Blue and Nile Blue increases with rising *p*H; the blue dyes are absorbed by the cytoplasm, the red only in the vacuoles.

A. CHEVALIER: Species, varieties and hybrids of American cotton actually cultivated in tropical Africa, and their improvement.

E. ROUBAUD and R. DESCHIENS. Capture of infectious nematode larvæ by predatory soil fungi. Active larvæ of a species of *Strongyloides* and of a species of *Ancylostoma* were captured and digested (under laboratory conditions) by mycelia of certain soil fungi, suggesting the possibility of biological control of these disease organisms.

W. DŒBLIN: Certain aleatory movements.

A. DEMOULIN: Theory of lines traced on a surface.

G. VAN DER LYN: Analytical representation of abstract polynomials.

J. DUFRESNOY: Exceptional values of meromorph functions in the neighbourhood of a given meromorph function.

V. PLATOFF: Measurement of the reaction of a gaseous jet by the pressure it exerts on a disk.

R. BARTHOLEYNS : New list of stars belonging to the Great Bear stream.

N. CABRERA : Law of multiplication of representative matrices of linear differential operators.

A. PÉRARD and C. VOLET : Improvements made in definition of the lengths represented by the international standards and in the comparison of these lengths. Certain of the standards have been re-engraved, and the apparatus for comparisons improved.

L. ZACHOVAL : Dispersion of ultra-sonic waves in castor oil.

J. BASSET : Fusion of graphite under very high pressure of argon, up to 4,000 kgm./cm.^{2}.

W. UYTERHOEVEN and C. VERBURG : Temperature of electrons I_e in a positive column discharge with alternating current (50 cycles) ; results for neon.

O. TE-TCHAO : Formation of large ions in gases as a function of the size of the particles in suspension.

MLLE. N. MORGULEFF : Absorption in the visible region of the spectrum by sulphur vapour.

P. LAINÉ and R. SERVANT : End emission of tubes of luminous gas ; part taken by reflections from the walls.

G. COURTOIS : Fusibility of mixtures of pure anhydrous sodium sulphide and carbonate.

M. FOËX : Influence of 'temper' on the density of sodic borate glasses.

J. COURNOT and M. BAUDRAND : Corrosion of welded joints of light alloys.

J. TIMMERMANS, J. DE ROOSTER and J. MICHEL : Spontaneous crystallization and the rate of crystallization of water and of heavy water.

(To be continued)

Amsterdam

Royal Netherlands Academy (*Proc.*, **41**, No. 10, 1938).

H. J. JORDAN, Miss C. E. SLUITER and N. POSTMA : Regulation of the muscle tonus by the ganglia pedalia in *Helix pomatia* L. according to the co-ordination scheme.

F. A. VENING MEINESZ : Forthcoming gravity expedition of Dr. W. Nieuwenkamp.

L. S. ORNSTEIN : The theory of liquid crystals.

L. S. ORNSTEIN, J. M. W. MILATZ, E. F. M. VAN DER HELD and W. MAAS : A sensitive method for the measurement of the excitation function of artificial radioactivity.

H. BRINKMAN, L. S. ORNSTEIN and W. LANGENDIJK : Photographic sensitometry for β-ray spectra.

L. S. ORNSTEIN, J. M. W. MILATZ, H. TEN KATE and M. MIESOWICZ : Conditions for the quantitative operation of a Geiger-Müller counter for β-rays. The ionizing power of β-rays as a function of their velocity.

J. G. VAN DER CORPUT and H. J. BACKER : Reaction velocity of mixtures (1). Bimolecular reaction of two mixed substances with a third substance.

L. G. M. BAAS BECKING : Cause of the high acidity in natural waters, especially in brines.

J. F. SCHOUTEN : The perception of subjective tones.

E. F. M. VAN DER HELD : Value of $G^2|M|^2$ in the theory of β-ray spectra.

C. S. MEYER : (1) Integral representations of Whittaker functions. (2) The Kummer function ${}_1F_1(a\,;\ b\,;\ z)$.

M. VAN EIJH : Influence of salt intake on root respiration in *Aster Tripolium*.

F. A. H. W. DE MAREZ OYENS : Preliminary note on the occurrence of a new ammonoid fauna of Permian age on the island of Timor.

R. BRUMMELKAMP : Ratio of the surface of the forebrain to that of the whole brain in higher apes and man.

J. L. ADDENS : Presence of a nucleus of Bellonci in reptiles and mammals.

J. DROOGLEEVER FORTUYN : Systematic arrangement of fibres in capsula interna, thalamus opticus and pes pedunculi.

P. C. FLU : The Mg^{++} cation and lysis of the *Bacterium megatherium* by the antimegatherium bacteriophage.

Washington, D.C.

National Academy of Sciences (*Proc.*, **24**, 525–565, Dec. 15, 1938).

H. D. BABCOCK : Some recent observations of sun-spot spectra. Preliminary results with a 21-ft. grating spectrograph with no optical parts except slit and grating, for use in the ultra-violet and photographic infra-red regions.

H. SHAPLEY : Second note on a metagalactic density gradient.

F. G. WATSON : Reflectivity and colour of meteorites. Using a self-recording spectral-photometer, it is concluded, from an examination of seven stony meteorites and one metallic, that they are essentially 'gray-bodies', so that the usual calculation of their temperatures in space are valid. Their geometrical albedoes range from 0·1 to 0·5 ; colour data do not differentiate between stony and metallic meteors.

W. J. CROZIER and E. WOLF : (i) Duplexity theory of visual response in vertebrates (2). Flicker response of a gecko (rod retina) is little different from that of the diurnal turtle (cone retina), throwing doubt on the validity of associating specifically histological appearance and function in the vertebrate eye. (ii) Specific constants for visual excitation (3). Various animals give the same fundamental form of flicker response curves. They have in common a large assemblage of excitation elements, the frequency distributions of which are fixed by specific genetic constitution.

L. W. LAW : Effects of chemicals on the lethal mutation rate in *Drosophila melanogaster*. Two methods were used : (1) injecting sub-lethal doses into the larvæ ; (2) immersing fertilized eggs from which the chorion was removed in solutions of sub-lethal concentration of the substances. Copper sulphate increased lethal mutation rate of the *X*-chromosome. Potassium permanganate and also iodine in potassium iodide produce a slight increase, but colchicine was ineffective.

F. A. BROWN, JUN. : An internal secretion affecting viability in Crustacea. Five species of crayfish (*Cambarus*) were used. Removal of the eyestalk, followed in some cases by injection of eye-stalk tissue into the abdomen, gives results indicating the production in eye-stalk tissue of a chemical substance which is essential to life.

L. M. BLUMENTHAL and G. R. THURMAN : Characterization of pseudo-$S_{n,r}$ sets.

B. DE SZ. NAGY : Semi-groups of self-adjoint transformations in Hilbert space.

G. A. MILLER : Groups of order p^m containing $m - \alpha$ independent generators.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Monday, February 20

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Dr. Franz Simon: "The Present Position and Future Objective of Low Temperature Research" (Succeeding lectures on February 22 and 24).*

Tuesday, February 21

UNIVERSITY COLLEGE, LONDON, at 5.15.—G. Tilgham Richards: "The Use of Museums. (3) The Science Museum."*

Thursday, February 23

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. Donald Stewart: "Industrial Incapacity and Modern Medicine" (Milroy Lectures. Succeeding lecture on February 28).

BEDSON CLUB, KING'S COLLEGE, NEWCASTLE-UPON-TYNE, at 6.30.—Dr. Olaf F. Bloch: "Some Scientific and Technical Applications of Photography" (Bedson Lecture).

Friday, February 24

ROYAL INSTITUTION, at 9.—S. Casson: "The Collapse of Ancient Civilization: a Study of Archæological Evidence."

Saturday, February 25

SCHOOL NATURE STUDY UNION (at University College, London), at 3.—Annual Conference. E. G. Boulenger: "Behind the Sciences in the Zoo Aquarium."

ASSOCIATION OF TECHNICAL INSTITUTIONS, February 24–25.—Annual General Meeting to be held in the Hall of the Merchant Taylors Company, Threadneedle Street, London, E.C.2.

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

LECTURER IN CHEMISTRY in the Dudley and Staffordshire Technical College and Dudley Training College—The Director of Education, Education Offices, St. James's Road, Dudley (February 20).

ASSISTANT (grade III—refrigeration) in the Ditton Laboratory, East Malling, Kent—The Establishment Officer, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, S.W.1 (February 22. Ref. *J* 39/2).

LECTURER IN METALLURGY in the County Technical College, Wednesbury—The Director, Secondary and Technical Department, County Education Offices, Stafford (February 23).

ASSISTANT FOR RESEARCH IN HOP DISEASES—The Secretary, Hop Diseases Investigations, c/o East Malling Research Station, Maidstone, Kent (February 25).

PROFESSOR OF MECHANICAL ENGINEERING in the Manchester Municipal College of Technology—The Principal (March 4).

ASSISTANTS (grades II and III) in the Meteorological Office—The Under-Secretary of State (S.2.B.(Met.)), Air Ministry, Adastral House, Kingsway, London, W.C.2 (March 4).

LECTURER IN HUMAN PHYSIOLOGY in the University of Manchester—The Registrar (March 6).

SECOND JUNIOR OBSERVER in the Solar Physics Observatory, Cambridge—The Director (March 7).

ASSISTANT LECTURER IN MATHEMATICS in the University of Manchester—The Registrar (March 11).

DIRECTOR OF THE COMMONWEALTH SOLAR OBSERVATORY, Mount Stromlo, Federal Capital Territory—The Office of the High Commissioner for Australia, Australia House, Strand, London, W.C.2 (March 15).

PHYSICAL CHEMIST in the Chemical Research Department, Dunlop Rubber Co., Fort Dunlop, Birmingham, 24—The Director.

SENIOR LECTURERS IN BACTERIOLOGY, PATHOLOGY AND ANIMAL HUSBANDRY in the Royal (Dick) Veterinary College, Edinburgh 9—The Secretary.

ASSISTANT INSPECTOR under the Alkali, etc., Works Regulation Act under the Department of Health for Scotland—The Secretary, Edinburgh, 2.

Reports and other Publications

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

University of Cambridge: School of Agriculture. Memoir No. 10: A Brief Summary of the Papers published by the Staffs of the School of Agriculture and its Associated Research Institutes during the Period Oct. 1st, 1937–Sept. 30th, 1938. Pp. 40. (Cambridge: School of Agriculture.) 1*s*. net. [231

Proceedings of the Royal Society of Edinburgh, Session 1937–1938. Vol. 58, Part 2, No. 10: The Anatomy of the Polychæte *Ophelia clutkensis* McGuire 1935. By Robert S. Brown. Pp. 135–150+1 plate. (Edinburgh: Robert Grant and Son, Ltd.; London: Williams and Norgate, Ltd.) 2*s*. 6*d*. [231

Scottish Marine Biological Association. Annual Report, 1937–38. Pp. 24. (Glasgow: Scottish Marine Biological Association.) [231

Board of Education. Report of the Consultative Committee on Secondary Education, with Special Reference to Grammar Schools and Technical High Schools. Pp. xxxviii+477. (London: H.M. Stationery Office.) 3*s*. 6*d*. net. [231

Publications of the International Tin Research and Development Council. No. 85: The Examination of some Tinned Foods of Historic Interest. Pp. 20. (Greenford: International Tin Research and Development Council.) Free. [231

The Standard of Living in Bristol: a Preliminary Report of the Work of the University of Bristol Social Survey. By Herbert Tout. Pp. 64. (Bristol and London: J. W. Arrowsmith, Ltd.) 1*s*. net. [231

Department of Scientific and Industrial Research: Water Pollution Research. Summary of Current Literature. Vol. 12, No. 1, January, Abstracts Nos. 1–125. Pp. 30. (London: H.M. Stationery Office.) 2*s*. net. [231

The School Health Services: their Initiation, Growth and Character. Pp. 112. (London: National Union of Teachers.) [231

Association of Special Libraries and Information Bureaux. Report of Proceedings of the Fifteenth Conference held at Lady Margaret Hall, Oxford, September 23rd to 26th, 1938. Pp. 134. (London: A S L I B.) 5*s*. [231

Emergency Medical Services. Memorandum No. 1: Structural and other Precautions against Air Raid Risks in Hospitals. Pp. 12. (London: H.M. Stationery Office.) 3*d*. net. [231

National Physical Laboratory. Abstracts of Papers published in the Year 1937. Pp. iii+71. (London: H.M. Stationery Office.) 1*s*. net. [231

Oilsgoil na h'Éireann (National University of Ireland). Calendar for the Year 1937. Pp. ix+316+608+386. (Dublin: National University of Ireland.) [231

The South-Eastern Naturalist and Antiquary: Being the Forty-third Volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Forty-third Annual Congress held at Worthing, 1938. Pp. lxxii+92+12. (London: South-Eastern Union of Scientific Societies.) 5*s*. net. [241

Hastings Natural History Society. Report and Balance Sheet for the Session 1937–38, with List of Officers and Members, etc. Pp. 14. (St. Leonards: Hastings Natural History Society.) [241

St. Thomas's Hospital Reports. Editors: Prof. O. L. V. S. De Wesselow, C. Max Page, assisted by N. R. Barrett, Dr. J. St. C. Elkington, Dr. A. J. Wrigley. Second Series, Vol. 3. Pp. 240+23 plates. (London: St. Thomas's Hospital.) 10*s*. [241

Publications of the International Tin Research and Development Council. No. 86: Calculation of the Area of Basis Metal exposed at Discontinuities in the Tin Coating of Tinplate. By W. E. Hoare. Pp. 8. (Greenford: International Tin Research and Development Council.) Free. [301

Other Countries

Contributions from the Physical Laboratories of Harvard University for the Year 1937. Series 2, Vol. 4. Pp. vii+54 papers. (Cambridge, Mass.: Harvard University.) [261

International Institute of Agriculture. Cotton Breeding and Seed Supply. (Appendix to the Monograph on "World Cotton Production and Trade".) Pp. 72. (Rome: International Institute of Agriculture.) [301

Publications of the Dominion Observatory, Ottawa. Vol. 12: Bibliography of Seismology. No. 19: Items 4021–4138, July, August, September, 1938. By Ernest A. Hodgson. Pp. 385–404. (Ottawa: King's Printer.) 25 cents. [301

Proceedings of the U.S. National Museum. Vol. 86, No. 3042: Descriptions of New and Little-known Fossil Lizards from North America. By Charles W. Gilmore. Pp. 11–26+1 plate. Vol. 86, No. 3043: The Cambaloid Millipeds of the United States, including a Family New to the Fauna and New Genera and Species. By H. F. Loomis. Pp. 27–66+1 plate. Vol. 86, No. 3044: Polyclads of the East Coast of North America. By A. S. Pearse. Pp. 67–98. Vol. 86, No. 3045: Hopewellian Remains near Kansas City, Missouri. By Waldo R. Wedel. Pp. 99–106+6 plates. Vol. 86, No. 3046: The Types of the Polychaete Worms of the Families Polynoidæ and Polyodontidæ in the United States National Museum and the Description of a New Genus. By Olga Hartman. Pp. 107–134. Vol. 86, No. 3047: Review of the Fishes of the Genera Polyipnus and Argyropelecus (Family Sternoptichidæ), with Descriptions of Three New Species. By Leonard P. Schultz. Pp. 135–156. (Washington, D.C.: Government Printing Office.) [301

Bulletin of the American Meteorological Society. Vol. 19, No. 5: Some American Papers and Notes on Climatic Variations; Report of the American Committee of the International Commission of Climatic Variations, to the International Geographical Congress, Amsterdam, Holland, July 1938. Pp. 64. (Milton, Mass.: American Meteorological Society.) 50 cents. [301